(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 April 2002 (11.04.2002)

PCT

(10) International Publication Number
WO 02/29765 A1

(51) International Patent Classification[7]: G09B 23/28

(21) International Application Number: PCT/US01/42512

(22) International Filing Date: 4 October 2001 (04.10.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/684,030 6 October 2000 (06.10.2000) US

(71) Applicant *(for all designated States except US)*: GAUMARD SCIENTIFIC, INC. [US/US]; 14700 S.W. 136th Street, Miami, FL 33196 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: EGGERT, John, S. [US/US]; 6075 S.W. 128th Street, Miami, FL 33156 (US). EGGERT, Michael, S. (M.D.) [US/US]; 5032 10th Court So., Birmingham, AL 35222 (US). VALLEJO, Phillip [US/US]; 4440 S.W. 5th Street, Miami, FL 33134 (US).

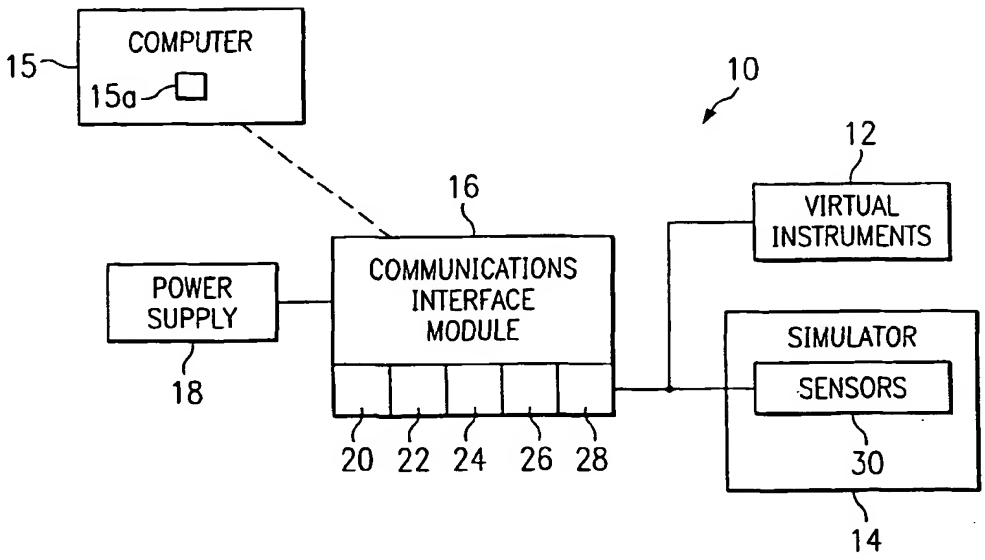
(74) Agents: HUBBARD, Brian, J. et al.; Haynes and Boone, LLP, 901 Main Street, Suite 3100, Dallas, TX 75202-3789 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: INTERACTIVE EDUCATION SYSTEM FOR TEACHING PATIENT CARE



(57) Abstract: An interactive education system for teaching patient care to a user is described. The system comprises a patient simulator (14); a virtual instrument (12) for use with the patient simulator in performing patient care activities; means (30) for sensing an interaction between the virtual instrument and the simulator, and means for providing feedback to the user regarding the interaction between the virtual instrument and the simulator.

WO 02/29765 A1

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations*

— *of inventorship (Rule 4.17(iv)) for US only*

— *of inventorship (Rule 4.17(iv)) for US only*

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERACTIVE EDUCATION SYSTEM FOR TEACHING PATIENT CARE

Cross-Reference to Related Application

This application is a continuation-in-part of co-pending U.S. Serial No. 09/640,700, filed August 17, 2000, which is a continuation-in-part of U.S. Serial No. 09/560,949, filed April 28, 2000, which is a continuation-in-part of co-pending U.S. Serial No. 09/199,599, filed November 25, 1998, which is a continuation of U.S. Serial No. 08/643,435, now U.S. Patent 5,853,292, filed May 8, 1996. The entire disclosures of the foregoing applications are hereby incorporated by reference.

Background

The present embodiment relates generally to an interactive education system for teaching patient care, and more particularly to such a system having virtual instruments for use with a child birthing patient simulator in conducting patient care activity.

While it is desirable to train students in patient care protocols before allowing contact with real patients, textbooks and flash cards lack the important benefit to students attained from "hands-on" practice. Thus, patient care education has often been taught using medical instruments to perform patient care activity on a simulator, such as a manikin. However, one disadvantage of such a system is that medical instruments are often prohibitively expensive, and consequently, many users must settle for using a smaller variety of instruments, even at the cost of a less comprehensive educational experience. One solution to the foregoing problem is using a set of relatively inexpensive, simulated medical instruments ("virtual" instruments), as taught in U.S. Patent No. 5,853,292, the entire disclosure of which is hereby incorporated by reference.

Another problem in patient care education is that the patient simulators used for teaching a user are generally passive. For example, in a child birthing simulation, a user must position the simulated fetus in a simulated maternal pelvis, move it down the birth canal, birth the fetus's head, rotate the fetus approximately ninety degrees to birth the shoulders, and finally, pull out the fetus, now referred to as a neonate. While replicating the sequence of events in a real delivery, the lack of verisimilitude resulting from physical manipulation of the fetus by the user undermines an appreciation for the difficulties of providing patient care. In a real delivery, the fetus is inaccessible, and most activity is obscured from view, and thus prior systems fail to address the most challenging conditions of providing patient care during child birthing. Moreover, prior systems fail to simulate cervical dilation as the fetus moves down the birth canal, thus failing to allow a student to assess the stage of delivery or construct a chart of cervical dilation versus time to assess the progress of delivery ("Partograph").

Therefore, what is needed is a system for an interactive education system for use in conducting patient care training sessions using relatively inexpensive virtual instruments in cooperation with a more realistic simulated patient, thereby enabling a user to learn comprehensive multiple and interrelated patient care skills.

Summary

The present embodiment provides an interactive education system for teaching patient care to a user. The system includes a patient simulator, a virtual instrument for use with the patient simulator in performing patient care activities, means for sensing an interaction between the virtual instrument and the simulator, and means for providing feedback to the user regarding the interaction between the virtual instrument and the simulator.

Brief Description of the Drawings

Fig. 1a is a schematic view of an illustrative embodiment of an interactive education system.

Fig. 1b is a schematic view of an interactive education system according to another embodiment.

Fig. 2 is a schematic view of the interaction between a set of virtual instruments and a patient simulator.

Fig. 3a is a perspective view with a cutaway of a virtual instrument.

Fig. 3b is a perspective view with a cutaway of a sensor.

Fig. 4 is a perspective view of an illustrative embodiment of a patient simulator.

Fig. 5a is a perspective view of the patient simulator of Fig. 4 with an attached cover.

Fig. 5b is a top plan view of a control box.

Fig. 6 is a perspective view of the torso of the patient simulator of Fig. 4.

Fig. 7 is a perspective view of Fig. 6 with the fetal portion of the patient simulator removed.

Fig. 8 is a perspective view of a distensible cervix of the patient simulator.

Fig. 9 is a perspective view of the exterior of the patient simulator.

Fig. 10 is a perspective view of a neonatal embodiment of a patient simulator.

Fig. 11 is a schematic view of an illustrative use of the present system.

Figs. 12-16 are screen display views generated by a program according to one embodiment of the present system.

Detailed Description

Referring to Fig. 1a, the reference numeral 10 refers, in general, to an interactive education system for teaching patient care protocols to a user. The system 10 comprises a set of virtual instruments 12 used to simulate medical instruments, and a simulator 14 used to simulate at least one patient for receiving patient care activity from the user. The virtual instruments 12 are tangible objects, and look, feel, and operate like real medical devices in conjunction with the simulator 14, which is understood to encompass a variety of forms, including a fully articulating and adult-sized manikin, as well as a fetus, a neonate, a child, a youth, or portion of a manikin, such as the arm, torso, head, or pelvic region.

Patient care activity received by the simulator 14 from the user, or users, is sensed in a manner to be described, and in response to the activity, the system 10 provides feedback to the user. It is understood that feedback may comprise any audio, visual, or tactile response. A computer 15 having a

program 15a is optionally connected to the system 10, for reasons to be described.

Referring to Fig. 1b, a system 10' comprises the computer 15 and the program 15a, wherein a software-generated set of virtual instruments 12' and a software-generated simulator 14' is provided. Thus, the patient care activity performed by the user comprises manipulating an icon relating to a selected software-generated virtual instrument 12' to provide patient care to the software-generated simulator 14'. In this embodiment, the program 15a uses conventional means, such as clicking a mouse or voice-activated software, to monitor activity by the user, and provides feedback in response, as will be described.

Returning to Fig. 1a, the system 10 further comprises a communications interface module ("CIM") 16, which receives operating power from a conventional power source 18, and contains a microcontroller ("PIC") 20. Microcontrollers are available from many vendors, such as Microchip Technology, Inc. (Chandler, Ariz.), and are then customized. As will be described, the PIC 20 receives input signals from the user's activity, and is programmed to respond in a certain manner to provide feedback to the user. For example, to provide audio feedback, the CIM 16 additionally includes an audio chip 22 which is responsive to the PIC 20 for causing a speaker 24 to produce realistic patient sounds, for example, heart, lung, blood pressure (Korotkoff), intestinal, fetal, and the like. A control 26 is included in the CIM 16 for adjusting the volume of the speaker 24.

Alternatively, depending on the complexity of the desired feedback, the CIM 16 may be connected to the computer 15 and program 15a. In one example of feedback, the program 15a could be used to provide a vast library, for example, of ultrasound profiles, or fetal distress monitor traces. Feedback could also be of body sounds, generated by the program 15a, and played through speakers of the computer.

The CIM 16 has a plurality of ports, collectively 28, for receiving input signals occasioned by interaction between the virtual instruments 12 and sensors 30 disposed on the simulator 14, resulting from the user's patient care activity. It is understood that there may be more than one PIC 20, and more than one CIM 16, to manage the input signals thus created.

The virtual instruments 12 comprise patient care devices, for example, as shown in Fig. 2, at least one IV needle, an endotracheal (ET) tube, an electrocardiogram (ECG or EKG) monitor, a blood pressure (BP) cuff, a pulse oximeter cuff, a temporary external pacer, an automatic external defibrillator (AED), a manual defibrillator, an ultrasound wand, a virtual stethoscope, a thermometer, and a fetal distress monitor, respectively 12a-l. Such virtual instruments look and operate like real medical devices. Of course, other virtual instruments are contemplated, as is the use of relatively inexpensive medical devices, such as a conventional stethoscope, a vacuum extractor, catheters, trays, IV stands, and the like.

Referring to Fig. 2, the IV needle 12a has a selectable group of specific drugs and dosages, and in one embodiment is part of a medication tray with an assortment of labeled syringes for dispensing the

drugs to the simulator 14, with the effects of administration controlled by the program 15a. The ET tube 12b is used in simulated patient airway management, and placed in a tracheal airway of the simulator 14. The EKG monitor 12c comprises a 3, 5, or 12 lead system, including a real-time trace monitor and R-wave sonic markers, and a plurality of color-coded patches for attachment to a torso of the simulator 14. The BP cuff 12d attaches to the simulator 14, for example, around an arm. The pulse oximeter finger cuff 12e attaches to the simulator 14, for example, around a finger. The temporary external pacer 12f has a plurality of anterior and posterior pacer pads for attachment to the torso of the simulator 14. The pacer 12f has controls for pacer rate and current, and exhibits rhythm pacing, cap time, and loss of cap time, all of which is controlled by the program 15a. The automatic external defibrillator (AED) 12g has a plurality of apex and sternum AED pads for attachment to the torso of the simulator 14. Upon selecting a software-generated shock button produced by the program 15a, the system 10 simulates defibrillation shock, with the resultant conditions controlled by the program 15a. The manual defibrillator 12h has a plurality of apex and sternum defibrillator paddles for contacting the torso of the simulator 14. Upon selecting a software-generated shock button, or alternatively by using a dual shock buttons associated with manual defibrillator 12h, the system 10 simulates defibrillation shock, with the resultant conditions controlled by the program 15a.

Still referring to Fig. 2, the ultrasound wand 12i interacts with the simulator 14, such that when the wand 30i is brought within a predetermined proximity of a predetermined anatomical area of the simulator, the CIM 16 detects the interaction and the program 15a supplies an ultrasound profile taken from a library of ultrasound images and or sounds. The program 15a may select between normal and abnormal profiles, requiring the user to interpret the profile and respond accordingly. The virtual stethoscope 12j interacts with the simulator 14, such that when the stethoscope 12j is brought within a predetermined proximity of a predetermined anatomical area of the simulator, the CIM 16 detects the interaction and feedback is supplied to the user, as will be explained below, with Figs. 3a-b. The thermometer 12k interacts with the simulator 14, such that when the thermometer 12k is brought within a predetermined proximity of a predetermined anatomical area of the simulator, the CIM detects the interaction and the program 15a supplies a temperature reading. The fetal distress monitor 12l (tocodynomometer) attaches to a portion of the simulator 14, and upon attachment, the program 15a supplies a heart rate reading for a simulated fetus.

Each instrument has a corresponding sensor 30a-l, as indicated by lines, collectively 36. Unless otherwise indicated, the lines 36 are schematic, and merely illustrate that the virtual instruments 12 and the sensors 30 are functionally connected to each other for providing an interaction created by the user's patient care activity, the interaction being reported as an input signal to the CIM 16. It is understood that the sharing of such physical lines among instruments 12, or sensors 30, is contemplated as well.

Interaction between the virtual instruments 12 and the sensors 30 may be electrical, optical,

pressure differential, tactile, temperature-controlled, or wireless. Generally speaking, an electrical interaction (which would also provide the input signal) could be created via a virtual instrument 12 having one node and a sensor 30 with another node, both of which are physically connected to the CIM 16, or by a virtual instrument with two nodes and a sensor formed of conductive material, or vice versa, only one of which may be physically connected to the CIM 16. For example, the IV needle 12a corresponds with a portion of the simulator 14 capable of accepting medications, such as the antecubital region of an arm, which may have a sensor 30a comprising an insulator sandwiched between two layers of conductive material having an appropriate thickness and weave density for permitting the needle 12a to pass through the cloth at a low acute angle (e.g., 20°). The conductive layers of the sensor 30a are electrically coupled to the CIM 16 via line 36a', such that when the needle 12a is correctly passed through the two conductive layers, simulating cannulation of a vein of the simulator 14, a circuit is completed between the layers and sensed by the CIM 16.

In another example of a method of sensing interaction, the ET tube 12b is used in simulated patient airway management, the simulator 14 having a head, eyes, a nose, a mouth, and a realistic airway capable of accepting conventional airway adjuncts, with the airway configuration adjustable to display a large tongue, an obstructed pharynx, or closed vocal cords, to increase the difficulty of the patient care activity. In order to confirm proper placement in the tracheal airway of the simulator 14, an optical sensor 30b is mounted in the wall of the trachea of the simulator 14 and connected to the CIM 16 via line 36b'. Correct placement of the ET tube 12b in the trachea is confirmed when the tip of the ET tube interrupts the beam of the optical sensor 30b. The sensor 30b may also be used to determine whether a fluid has passed.

The virtual stethoscope 12j provides an example of a wireless method of sensing interaction. At least one sensor 30j is placed at an anatomical location on the simulator 14 where specific heart, lung (including airway), Korotkoff, fetal, or other sounds are normally heard. The sensor 30j provides at least one signal which is identified by the stethoscope 12j, thereby directing an integrated sound circuit to play a sound to the user appropriate for the anatomical location of the sensor on the simulator 14. It is understood that the sound circuit has a stored library of body sounds corresponding to the location of the selected sensor 30j, and that the sensor 30j is illustrative of any number of similar sensors.

Referring to Fig. 3a, in some respects, the appearance of the stethoscope 12j resembles a standard stethoscope, having earpieces 50a-b for hearing sounds, and being connected to extenders 51a-b, which are joined to a bifurcated ear tube 52. Similarly, the stethoscope further comprises a bell tube 54, and a bell 56, preferably made of nonferrous material. However, unlike conventional stethoscopes, an electronic control box 58 is disposed between the ear tube 52 and the bell tube 54. The control box 58 is understood to be an appropriately developed CIM 16, physically integrated into the virtual instrument 12j, thus simplifying the system 10. A jack 64 is provided on the control box 58 for output to an external

speaker (not depicted), so that other users may hear the sounds heard in the earpieces 50a-b. This not only increases the number of users who benefit from the patient care activity, but allows an instructor to test the user's ability, and correct the user's technique if required. The control box 58 retains a small power source 66, such as a battery, an acquisition circuit 68 and a sound circuit 70 (see copending U.S. Application Ser. No. 09/640,700, filed Aug. 17, 2000, for circuit diagrams) for directing a small speaker 72, such as is available from ADDAX Sound Company (Northbrook, Illinois), to play a predetermined sound. The speaker 72 is disposed in the earpiece 50a, and connected to the control box 58 via a wire 72a, allowing the user to hear the sounds produced by the sound circuit 70. It is understood that a second, substantially identical speaker may be disposed in the opposite earpiece 50b, and also connected to the control box 58. In an alternative embodiment, the speaker 72 may be disposed in the control box 58, and sounds transmitted via conventional ear tubes to the ear pieces. The sound circuit 70 is also connected to the jack 64 for allowing connection to an external speaker for the above-described reasons.

A switch 74, having a number of positions, is disposed on the control box 58 for switching between groups of sounds, for example exemplary normal and abnormal sounds that may be those heard in an adult, neonate, or fetus. An RF (radio frequency) signal acquisition coil 76, such as is available from M.C. Davis Co. (Arizona City, Ariz.), is disposed in the interior of the bell 56 for transmitting and acquiring RF signals, as will be explained. The acquisition coil 76 is a copper coil and circuitry having an associated wire 76a, which is attached to the electronic control box 58. A polymeric disc 78 is disposed between the acquisition coil 76 and the bell 56 to decrease noise from the bell.

Referring to Fig. 3b, the sensor 30j is disposed beneath the skin 14b of the simulator 14 to avoid visual detection by the user. Likewise, it is advantageous that the sensor 30j have a minimal thickness to prevent intentional or accidental detection, as some anatomical locations, for example, intercostal spaces, must be palpated in order to be located. In an alternative embodiment, the sensors 30j may be affixed to an overlay (not depicted) substantially similar to the skin 14b, thus allowing the overlay to be placed over other simulators and models of patients, thereby converting those devices to allow them to be used with the stethoscope 12j.

The sensor 30j comprises an RF ID tag 80, such as is available from Microchip Technology, Inc. (Chandler, Ariz.) (Part No. MCRF200-I/3C00A), which may be programmed using "Developer's Tools" also sold by Microchip Technology, Inc. to engender a unique signal that serves to identify the particular sensor 30j. A coil 82, such as is available from M. C. Davis Co. (Arizona City, Ariz.), is operably connected to the tag 80. The tag 80 and coil 82 are potted in RTV potting material 84, or silicon rubber, such as is available from M. C. Davis Co. (Arizona City, Ariz.), to prevent damage. Once potted, the tag 80 and coil 82 collectively form a COB module 86 which emits a signal comprising a unique train of frequencies when interrogated.

In operation, the COB module 86 may actively broadcast the frequencies, but preferably the COB

module is passive, that is, only activated when interrogated by the acquisition coil 76 in the stethoscope bell 56. In this preferred embodiment, the acquisition coil 76 delivers a carrier signal, such as a 125 kHz excitation frequency, which is received by the COB module 86 when the bell 56 is brought within a predetermined proximity, or acquisition distance, of the COB module. The acquisition distance of the bell 56, and therefore the acquisition coil 76, to the COB module 86 is determined by the strength to noise (S/N) ratio of the carrier signal. Thus, adjustment of the S/N ratio of the carrier signal provides a means for controlling the precision with which the user must place the stethoscope bell 56 in relation to the anatomical location of the sensor 30j, and therefore the COB module 86. Precise placement of the bell 56 on the simulator 14 by the user is rewarded with feedback, in the form of an appropriate body sound. Normally, the S/N ratio is set to require that the bell 56 be brought within approximately one-half to two centimeters of the COB module 86 of the sensor 30j.

In response to receiving a sufficiently strong carrier signal, the COB module 86 emits a train of two identifying frequencies for use in a process conventionally known as frequency shift keying (FSK), although other keying methods could be used. The acquisition coil 76 in the stethoscope bell 56 receives the emitted frequencies and relays the signal to the acquisition circuit 68, which determines the identity of the sensor 30j. As the anatomical position of each sensor 30j is known to the programmer, a selection of appropriate body sounds associated with each sensor is provided, and accessible to the sound circuit 70. Thus, by identifying the sensor 30j, the acquisition circuit 68 directs the sound circuit 70 to play an appropriate body sound for the anatomical position of the COB module 86, which is heard by the user through the speaker 72 disposed in the earpiece 50a. It can be appreciated that to expose the user to a greater selection of sounds, more sensors 30j could be added to the simulator 14, or each sensor could correspond to more than one sound. As depicted, the switch 74 has five different positions, and includes means for switching the sound circuit 70 between five different groups of sounds. Thus, it is understood that the number of switch positions corresponds to the number of sounds that can be produced by a single sensor, i.e., with thirteen sensors and five switch positions, the user could listen to up to sixty-five location-appropriate sounds, including examples of normal and abnormal sounds.

It can be appreciated that the above-described acquisition coil and COB module may be adapted to be used with the respective leads, paddles, or probes ("connectors") of the ECG monitor 12c, the temporary external pacer 12f, the automatic external defibrillator (AED) 12g, the manual defibrillator 12h, the ultrasound wand 12i, and the fetal distress monitor 12l. If desired, the connectors may be equipped with adhesive to temporarily hold them in place on the patient simulator. The interaction between the instruments' connectors and the sensors 30, as sensed by the CIM 16, confirms proper placement. The hidden location of the sensors 30 beneath the skin of the patient simulator further challenges a user's patient care skills, as well as more closely mimicking a real patient.

It is understood that the simulator 14 is designed to represent a patient and receive treatment, and

as such the simulator 14 could take a variety of forms, including a fully articulating and adult-sized obstetrics simulator, a curled fetus, an articulating fetus, multiple fetuses, or a neonate, as well as a portion of simulated patient, for example, the torso and pelvic region.

Referring to Figs. 4 and 5a, in an illustrative embodiment, the simulator 14 comprises a child birthing maternal simulator 300 and a removable associated fetal simulator 302. The maternal simulator 300 has a head 304, with hair 306, eyes 308a-b, a nose 310, and a mouth 312. The head assembly contains a realistic airway (not depicted) capable of accepting conventional airway adjuncts. Sensors, generally denoted 30 (Fig. 1a), may be disposed on the skin of the maternal simulator (shown as stippled) and/or beneath the skin (shown in phantom). It is understood that in one embodiment of the maternal simulator (not depicted), no sensors are associated with the simulator. Lines 36 protrude from the torso 316 for providing electrical, pneumatic, or fluid connections, as well as for connecting the sensors 30 to the CIM 16, if necessary.

A pair of arms 318a-b are connected to the torso 316. At least one arm contains an IV receptacle (not depicted) capable of accepting medications, and sensors 30a may be placed within the receptacle to ascertain whether an IV has been started. Similarly, the arm may contain a sensor 30d for auscultation of Korotkoff sounds, as well as means for measurement of blood pressure. A pelvic region 320 of the torso 316 receives a pair of legs 322a-b.

Referring to Fig. 5a, a cover 324 may be attached to the torso 316 via a plurality of snaps 324a, although other reversible fastening means, such as hook and loop closures may be used. The cover 324 retains sensors 30, for cooperating with the ultrasound wand 12i, fetal distress monitor 12l, and the stethoscope 12j, or alternatively at least one small speaker, to allow simulation of fetal heart sounds which may be detected by the stethoscope 12j or a conventional stethoscope, respectively. In one embodiment, the cover 324 surrounds an open cell foam (not depicted) connected to means for producing a vacuum. Activation of the vacuum shrinks the foam, making it feel harder, which simulates uterine contractions by the maternal simulator 300. Alternatively, the cover 324 may retain an air bladder and associated line (not depicted) for pressurizing the cover, thus making it feel harder. It is understood that different levels of hardness may be produced to simulate different levels of contraction strength, for example, mild, moderate, and strong contractions. If connected to the CIM 16 and program 15a, the contractions could be spaced at regular intervals, and associated data for maternal intrauterine pressure may be displayed by the program, as will be discussed with Fig. 14.

Returning to Fig. 4, the fetal simulator 302, has an umbilical cord 302a and placenta 302b, and is depicted as resting upon a removable stage 325 disposed inside the maternal simulator. The removable stage 325 has a bladder (not shown), a line 325a, and a bulb 325b. When the bulb 325b is used to pump air into the bladder, the stage 325, and hence the fetal simulator 302, is raised relatively upwards. When covered with the cover 324 (Fig. 5a), raising of the stage 325 allows a user to palpate the fetal simulator

302 through the cover to assess position, as well as to perform Leopold maneuvers.

A birthing device 326 is disposed inside the torso 316, as will be described. The cover 324 is designed to obscure the fetal simulator 302 of the simulator and the birthing device 326 from view, thus more accurately simulating the child birthing process, and challenging the user's diagnostic abilities. With the stage 325 removed, the birthing device 326 may be operated via a manual crank (not shown), or by a small motor 326a connected via a line 326b to controlling means for turning the motor on or off, as well as determining operational speed.

In a first embodiment, software of the program 15a controls the birthing device 326, as will be discussed in conjunction with Fig. 14, below. In an alternative embodiment, the controlling means is a control box 328, and a line 330 which connects the control box 328 to the CIM 16. Referring to Fig. 5b, the control box 328 has controls 328a-d for respectively turning the simulator 14 on and off, pausing and resuming child birthing, determining the speed of the delivery rate, and setting the fetal heart rate.

Referring to Figs. 6 and 7, the torso 316 of the maternal simulator 302 is shown with the cover 324 removed to expose the fetal simulator 302. The fetal simulator 302 is disposed in a cavity 333 of the maternal simulator 300, and has a head 334, an attached torso 336, with a pair of arms 338a-b and legs 340a-b attached to the torso. The head 334 is soft to allow for vacuum extraction, and has a mouth and nose which may be suctioned by the user. The umbilical cord and placenta 302a-b (Fig. 4) are removed to simplify the illustration, but it is understood that the placenta 302b (Fig. 4) could be disposed in any number of common orientations, such as normal fundal, low placement, or placenta previa, and attached to the cavity 333 with conventional removable fasteners. Likewise, the umbilical cord 302a (Fig. 4) could be presented to replicate various complications, and may house connecting lines to the fetal simulator 302 to allow an umbilical pulse to be felt by the user, or to convey electricity to the fetal simulator 302, if necessary.

A receiver 342 is disposed on the fetal simulator 302 to allow the birthing device 326 to retain the fetal simulator. Other receivers, similar to the receiver 342, are contemplated on different portions of the fetal simulator 302, such as to simulate a breech birth, and as the fetal simulator 302 articulates, a variety of breech deliveries, such as full, frank, and footling may be simulated.

The birthing device 326 has a projection 344 of a ram 346 which cooperates with the receiver 342 of the fetal simulator 302 to retain the fetal simulator. In the depicted embodiment, the ram 346 is driven by a drive system, including a small electric motor, gears, electronic logic to permit resetting, means to determine the position of the ram, and a forward and reverse function. The ram 346 proceeds down a set of tracks 347a-b, thereby translating the fetal simulator 302 out of the maternal simulator 300.

The projection 344 of the ram 346 is rotatable, the birthing device 326 thereby producing both rotational and translational movement of fetal simulator 302, to simulate a realistic child birthing scenario, wherein the fetus makes a turn to bring it to a normal nose down position of crowning, and it

makes another turn after crowning to allow its shoulders to better pass through the birth canal.

In one embodiment, levers 346a-b of the ram 346, being operably connected to the projection 344, engage cams 348a-b, respectively, to produce rotation. As the ram 346 proceeds down the tracks 347a-b, the levers 346a-b of the ram engage the fixed cams 348a-b in turn, causing the respective lever to move. Movement of the lever rotates the projection 344. Eventually, the respective lever is moved to a point where the lever clears the respective cam. It can be appreciated that the cams 348a-b may be located at places along the tracks 347a-b where rotation is desired, the tracks simulating the birth canal. Thus, internal rotation of the fetus is produced by the lever 346a engaging the cam 348a, and external rotation of the fetus is produced by the lever 346b engaging the cam 348b. Alternatively, the program 15a allows for adjustment of the rotation of the projection 344 from zero to one hundred and eighty degrees, as will be discussed with reference to Fig. 14, below. In either embodiment, the fetus 302 passes through a distensible cervix 350, as will be described.

Referring now to Figs. 8 and 9, the distensible cervix 350 comprises a ring 352 having attached flaps 353a-b for maintaining the cervix's position in the cavity 333. As such, the flaps 353a-b may have attached snaps, hook and loop closures, or other reversible fastening means. A wall 354 is connected to the ring 352, and is preferably of an elastic material, such as Lycra®. A gathering 356 of the wall material defines a port 358. The gathering 356 may have an associated elastomeric element disposed interiorly to enhance the elasticity of the port 358. Alternatively, the wall 354 itself may provide sufficient elasticity.

The port 358 expands from about two to ten centimeters in diameter as the fetal simulator 302 is pushed through the port, and because of the shape of the fetal simulator's head 334, and the elasticity of the wall 354, dilation is automatically simulated coincident to fetal descent. The user may then practice measuring cervical dilation and plot labor progress as a Partograph. The elasticity of the wall 354 may be adjusted, for example by using thicker or thinner wall material, to produce a cervix having faster or slower dilation than normal, respectively. The cervix 350 is disposed concentric to the pelvic area 320, which has a pubic bone 360, as well as several cover snaps 324a.

The fetal simulator 302 moves through the cervix 350 and out of the cavity 333 past vulva 362. The vulva 362 are made of a flexible material so that the user may manipulate the vulva, or perform an episotomy to birth the head 334. It is understood that the vulva 362 may comprise a portion of an insert (not depicted) including features such as a urinary tract and rectum, which could be replaceable with other genital inserts for displaying various patient conditions. After delivery, the user may practice postpartum exercises, such as massaging a uterus insert (not depicted) back to a desirable size, removing retained placenta parts (not depicted), or repairing the cervix 350 or vulva 362.

In one embodiment, the torso 316 contains a simulated heart, lungs, and ribs. The heart (not depicted) beats by the action of a pulsatile flow which is controlled by the program 15a in response to the

condition of the patient and upon therapeutic interventions. Palpable pulses may be found at carotid, brachial, radial, femoral, and pedis dorsis locations. Specific pulse locations become non-palpable as the systolic pressure falls, and the absence or presence of a pulse will depend upon the simulated blood pressure. Heart sounds are heard at appropriate locations through the use of the stethoscope 12j. The heart beat is synchronized with the Virtual EKGs, which are determined by the program 15a. Application of the stethoscope 12j to a point below the BP cuff 30d (Fig. 2) will cause the appropriate Korotkoff sounds to be heard.

The maternal simulator 300 displays a combination of ventilation means, and lung and airway sounds are heard at appropriate locations using the stethoscope 12j. The simulator 300 breathes spontaneously in a manner that would achieve targeted arterial blood gases for a given situation, including response to interventions such as ventilation and administration of drugs, and demonstrates the amount of chest rise relating to the tidal volume and physiologic states. Normal gas exchange lung dynamics are virtual and are controlled by the program 15a, which may also determine tidal volumes (TV), functional residual capacity (FRC), and expired carbon dioxide (CO_2). Airway resistance, lung and chest wall compliance are also controlled by the program 15a.

The heart and lungs are connected to pressure transducers confirming airway ventilation and cardiac compression. For example, an air line may be mounted in tracheal wall or lungs of the simulator 300 and connected to a sensor circuit connected to the CIM 16 so that when cardiopulmonary resuscitation (CPR) ventilation is performed on the simulator, the CIM 16 monitors the timing and magnitude of the pressure and volume of the ventilation procedure, via the air line and the sensor. Similarly, a compression bladder may be embedded within the heart or chest cavity of the simulator 300 for sensing and confirming proper timing and magnitude of a CPR chest compression procedure, when connected by an air line to a compression sensor circuit attached to the CIM 16. It can be appreciated that compression and ventilation data is acquired from pressure waves sensed by the CIM 16 through the lines 36. The blood pressure, heart rate, and oxygen saturation is virtually measured by the BP cuff 30d (Fig. 2) and the Pulse Ox cuff 30e (Fig. 2), although the data displayed is generated by the program 15a.

Referring to Fig. 10, a neonate simulator 302' may be used to replace the fetal simulator 302 (Fig. 8) to allow practice of neonatal resuscitation according to the program 15a. The neonate 302' has a head 370, with hair 372, eyes 374a-b, a nose 376, and a mouth 378. The head assembly contains a realistic airway (not depicted) capable of accepting conventional airway adjuncts and a sensor for determining whether an airway adjunct has been placed, or whether a fluid has passed. The head 370 is connected via a neck 380 to a torso 382.

Sensors, generally denoted 30 (Fig. 1a), may be disposed on the skin of the neonate simulator (shown as stippled) and/or beneath the skin (shown in phantom). Lines 36" protrude from the torso 382 for providing electrical, pneumatic, or fluid connection, as well as for connecting sensors (not depicted)

to the CIM 16. The torso 382 has an umbilical site 384, which provides a site for catheterization, and a simulated heart, lungs, and ribs for performing CPR. The heart and lungs are connected to pressure transducers as described above for the maternal simulator 300 for confirming airway ventilation and cardiac compression. The neonate simulator 302' exhibits many of the same features as the maternal simulator 300 (Fig. 6), including heart rate, pulse, oxygenation, and a variety of body sounds which can be detected using the stethoscope 12j (Fig. 2) or a conventional stethoscope. A pair of arms 386a-b, and a pair of legs 388a-b, are also connected to the torso 3382.

In one embodiment, the hands and feet as well as the face and upper torso change color based upon proper oxygenation or an oxygen deficit. As oxygenation decreases, the extremities (peripheral cyanosis) change color first, followed by the face and upper torso (central cyanosis). Such change is reversible as oxygenation is improved.

In a preferred embodiment, coloration is achieved using blue thermochromatic dye (such as Reversatherm Blue Type F, available from Keystone, Chicago, Ill), approximately 3 grams dissolved in 10 grams of clear vinyl paint thinner, and dispersed into 300 grams of clear vinyl paint. The mixture is applied to the hands, feet, chest, and face. At room temperature, the neonate is blue. Resistance heaters (such as available from Minco Products, Minneapolis, MN) are connected in parallel, and placed under the skin to provide 5-15 watts/in^2, or heat energy sufficient to raise the surface temperature of the skin to about 115°, causing the bluish color to disappear. Power for the heater is supplied through the CIM 16. The peripheral and central heaters may be separately controlled to allow peripheral cyanosis without central cyanosis. Heat sinks may also be disposed with the heaters to allow faster cooling, and hence, faster changes in coloration.

In one embodiment, the thermochromatic system is logically linked to the program 15a, for example, an instructor defines the condition of the neonate. Afterwards, coloration is responsive to CPR quality being performed by a user, either improving, worsening, or remaining the same. The program 15a also provides for an override if coloration changes are not desired. Coloration may alternatively be simulated by having applied a conventional photochrome to the simulator, such that upon exposure to an associated adjustable UV light, the simulator appears to turn blue.

Referring now to Fig. 11, a child birthing system 500 illustrates the use of the foregoing embodiments. The simulator 14, for example, the maternal simulator 300 and fetus 302 are placed on a table 502. Students, W, X, Y, and Z, take places around the table, for example, W controls medication, Y controls virtual instruments 12, X controls anesthesia, and Z controls obstetrics. The child birthing device 326, as discussed above, may be driven via a manual crank or by a small motor 326a connected to either a control box 328, or the program 15a of the computer 15 may optionally (shown in phantom) control the birthing device 326. Whichever controlling means are used, the distensible cervix accurately reflects progress of the fetal simulator down the birth canal. Eventually, as described above, the fetal

simulator is birthed.

Once the fetal simulator is birthed, a team W', X', and Y' (which are understood to be the same students W, X, and Y, or others depending on class size) moves along path 1 to practice neonatal care on a table 502'. At least one team, denoted by the absence of Z, must remain behind with the maternal simulator for monitoring and potential stabilization. The fetal simulator is switched with a neonatal simulator 14', for example, neonatal simulator 302' (Fig. 10). If connected to the computer, the program 15a may be used to simulate the need for neonatal resuscitation, and CPR and other emergency care protocols may be performed. The program 15a monitors the care received by the simulator via the CIM 16 and virtual instruments 12, and compares the care to accepted standards.

Meanwhile, the program 15a of the computer 15 may be used to simulate the need for maternal resuscitation. If so, a team moves along path 2 to practice maternal care on a table 502". Students, W", X", Y", and Z can work on the maternal simulator 14", for example maternal simulator 300 with the fetal simulator removed. CPR and other emergency care may be given, and the program 15a monitors the care received by the simulator via the CIM 16 and virtual instruments 12.

Referring now to Fig. 12, an introductory screen display 400 of the program 15a is presented on the computer 15 for teaching patient care protocols to a user. The display 400 includes several decorative features: a title box 402, a fetal heart rate box 404, a maternal intrauterine pressure box 405, a vital signs box 406, and an ultrasound video box 407. The display 400 also contains a teaching box 408, a testing box 410, and a virtual instruments box 412. As will be described, in some modules, the program 15a compares information pertaining to the user's activity with predetermined standards.

The screen 400 also displays a group of selectable patient care modules 414a-p provided by the program 15a, which furnish information on medical topics and associated concepts. Each module has a single topic, and represents an interactive patient care training session for the user. The modules 414a-g are disposed in the teaching box 408, and give an overview of relevant physiology, pregnancy, complications, labor and birth, postpartum, and maternal and neonatal resuscitation protocols. The modules 414h-j are disposed in the testing box 410, and give an opportunity to test a user in maternal and neonatal resuscitation protocols, as well as instructor defined protocols (Codemaker). An exit button 415 for exiting the program 15a is also disposed in the testing box 410. The modules 414k-p are disposed in the virtual instruments tutor box 412, and give a user a tutorial on use of the system, including automatic birthing, fetal ultrasound, fetal distress monitor, vital signs, Partographs, and heart and lung sounds.

Referring to Fig. 13, if one of the modules (Fig. 12) is selected by the user, such as by voice recognition or selection with a mouse of the computer 15, the program 15a displays a display screen 416. The display screen 416 contains an information box 418, which contains topical information. The display screen 416 also has a menu bar 420 containing information items (illustrated as A-D for convenience) listing information categories specific to the topic of the selected module. It is understood

that an item may be selected from the screen 416 via the menu bar 420, and that each module 414a-p has its own display screen with its own menu of specific informational items A-D, which may be expanded to include a large number of items, or condensed for example, by placing selectable sub-items under an item.

Selection of an item from a menu, other than an exit item, causes text and/or illustrations topical to the selected menu item to be displayed in the information box 418. In practice, the program may generate a new display screen (not depicted). As such, it is understood that the information screen 416 is used as an example of any number of screens, and furthermore, such screens can be displayed in sequential order, or a series, for each item. A series of screens, such as screen 416, comprises a tutorial regarding patient treatment protocols for the selected menu item. Thus, the user can review information from a library of topics by selecting the appropriate module, and item, and then navigating through a series. Navigation in a series of screens is attained by the user's selection between three boxes: 422, 424, and 426, respectively "Back", "Next", and "Exit", with corresponding function among the screens, such as proceeding backwards or forwards in the series. If no "Back" or "Next" function is possible, as respectively would be the case of the first and last screen of a series, the boxes 422 or 424 may be unselectable.

For example, modules 414f and 414g, each engender a series to teach a user about maternal and neonatal resuscitation, respectively. The user may also practice CPR on the simulator 14 (Fig. 1a), such as the maternal simulator 300, or the neonatal simulator 302', above, and the program 15a senses the user's compression and ventilation, via the CIM 16 (Fig. 1a) and sensors 30 (Fig. 1a). The heart and lungs of the simulator 14 are connected to pressure transducers confirming airway ventilation and cardiac compression; for example, an air line may be mounted in tracheal wall of the simulator 14 and connected to a sensor 30 connected to the CIM 16, so that when CPR ventilation is performed on the simulator, the CIM 16 monitors the timing and magnitude of the pressure and volume of the ventilation activity, via the air line and the sensor. Similarly, a compression bladder may be embedded within the chest cavity of the simulator 14 for sensing and confirming proper timing and magnitude of a CPR chest compression procedure, when connected by an air line to a compression sensor 30 attached to the CIM 16. The program 15a compares the information pertaining to the user's activity with predetermined standards, and thus provides an interactive training session.

The predetermined standards are selectable, and reflect medical protocols used around the world, including BLS and ACLS guidelines set forth by the American Heart Association and others. At least seven major protocols for cardiopulmonary resuscitation (CPR) are stored and selectable by the user. Moreover, a user may update the protocols, or enter and store a "New Protocol" reflecting the local protocol regarding depth, duration, and frequency of cardiac compressions and airway ventilations. The program will use this series of acceptable limits to generate a new CPR waveform for testing CPR.

Referring back to Fig. 12, selection of a test module 414h-j from the test box 410 directs execution of the program 15a to provide a testing sequence to help test the user on patient care protocols, such as maternal and neonatal resuscitation, and other responses to emergency scenarios. The program 15a paces through the steps of a patient distress scenario, giving the user a predetermined time to respond or complete the task required, thus enabling the user to experience the pressure of a emergency situation. For example, the program 15a may test the user by presenting choices from which the user must select in order to treat the patient, wherein the user must complete the correct choice before the sequence proceeds to the next event. The program 15a enables the user to enable, disable, or check the virtual instruments 12 and sensors 30 for connection to supply input to the CIM 16.

If the virtual instruments 12 (Fig. 2) are enabled, the user may implement patient care activity on the simulator 14 using the virtual instruments 12, while having the results and quality of response being monitored by the program 15a. Alternatively, the user may use software-simulated instruments 12' (Fig. 1b) generated by the program 15a. The program 15a advances through the scenario until the patient recovers, and provides a running critique of the user's responses, with an explanation of each incorrect choice or action. Features of the test modules 414h-j include items that enable the user to specify that action sequences prescribed by the scenario comprise a predetermined number of compression/ventilation cycles on the simulator 14, or to allow the user to record the time and magnitude of the compression and ventilation activity performed on the simulator 14, or to select among a group of choices for hearing realistic sounds.

Testing may be defined by the program 15a, as above, or by the user. For example, selection of the Codemaker Test module 414j (Fig. 12) allows a first user, for example, an instructor, to create a scenario to test a second user, for example, a student. The first user may input preliminary data to define the patient simulator of the testing scenario by entering a set of preliminary patient parameters regarding information such as sex, weight, and age, as well as patient indications, vital signs and cardiac rhythms which will be realistically reflected in the vital signs monitor 406 (Fig. 12). An instructor defined testing system allows the instructor to test the student on local, national, or international patient care protocols. Many algorithms are selectable by opening files, including BLS, ACLS, Pediatric, and Obstetric (OB) emergencies. Other algorithms may be created and stored, and algorithms may be linked together as well. Benefits of this module include flexibility for instruction and the ability to detect mastery of the subject. An instructor-defined algorithm would presumably vary from well-known, structured algorithms, and thus avoid the problem of rote memorization of responses by the student.

Action may be taken in response to the conditions by the student, for example, the student may select among virtual instruments to use to render patient care activities. The student may then perform the patient care activities virtually, or using the tangible simulator.

Use of the modules 414k-p of the virtual instruments tutor box 52 provides information about

instruments commonly used in child birthing scenarios. In some instances, opportunities to practice using some of the virtual instruments 12 in patient care protocols with the simulator 14 are provided.

Turning now to Figs. 14 and 15, the entire child birthing process may be automated via the program 15a, with the user merely defining initial conditions, such as delivery time 430, delivery profile 432, and contraction intensity 434. The warp feature allows a full delivery to be condensed from 16 hours to 5 minutes. Child birthing then consists of placing the fetal simulator 302 on the projection 344, and placing the cover 324 on the maternal simulator 300. The program 15a also offers a varying rate for progress of the ram 346, i.e., the first few centimeters may proceed much more slowly than the last few centimeters to better simulate child birth.

Referring to Fig. 16, if module 414m (Fig. 12) is selected, a series of screens are shown regarding the fetal distress monitor, with tutorial information. An exemplary fetal distress monitor box 436 is depicted, along with a selectable On button 436a for turning on the monitor. The fetal distress monitor 12l cooperates with the simulator 14, the fetal heart monitor is placed on the cover 324 of the maternal simulator 300 (Fig. 5a) and interacts with at least one sensor 30, while the contractions monitor interacts with another sensor 30 disposed on the cover.

Although illustrative embodiments have been shown and described, a wide range of modification, change, and substitution is contemplated in the foregoing disclosure and in some instances, some features of the present embodiment may be employed without a corresponding use of the other features. It is understood that several variations may be made in the foregoing without departing from the scope of the embodiment. For example, the system 10 may be modified by simply modifying the program 15a and/or the virtual instruments 30 and sensors 30. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the embodiment.

Claims

WHAT IS CLAIMED IS:

1. An interactive education system for teaching patient care to a user, the system comprising:

a patient simulator;

a virtual instrument for use with the patient simulator in performing patient care activities;

means for sensing an interaction between the virtual instrument and the simulator, and

means for providing feedback to the user regarding the interaction between the virtual instrument and the simulator.

2. The system of claim 1 wherein the means for providing feedback to the user regarding the interaction between the virtual instrument and the simulator is a microcontroller.

3. The system of claim 1 wherein the means for providing feedback to the user regarding the interaction between the virtual instrument and the simulator is a computer program.

4. The system of claim 1 wherein the virtual instrument is selected from a group consisting of at least one IV needle, an ET tube, an ECG monitor, a BP cuff, a pulse oximeter cuff, a temporary external pacer, an AED, a manual defibrillator, ultrasound wand, a virtual stethoscope, a thermometer, and a fetal distress monitor.

5. The system of claim 4 wherein the means for sensing an interaction between the virtual instrument and the simulator is a sensor.

6. The system of claim 5 wherein the interaction is between an acquisition coil of the virtual instrument and a COB module of the sensor.

7. An interactive education system for teaching patient care to a user, the system comprising:

a computer having a program for displaying a selection of selectable modules for providing different interactive training sessions;

a patient simulator operably connected to the computer; and

a virtual instrument for use with the simulator in performing patient care activities

means for sensing an interaction between the virtual instrument and the simulator; and

means for providing feedback to the user regarding the interaction between the virtual instrument and the simulator.

8. The system of claim 7 wherein at least one of the modules provides controls for the patient simulator to respond to patient care activity.

9. The system of claim 7 wherein the feedback is provided as an audible presentation of sounds.

10. The system of claim 7 wherein the simulator represents an adult patient.

11. The system of claim 7 wherein the simulator represents a non-adult patient.

12. The system of claim 7 wherein the simulator represents a portion of a patient.

13. The system of claim 7 wherein the means for sensing an interaction between the virtual instrument and the simulator is a sensor.

14. The system of claim 13 wherein the interaction is between an acquisition coil of the virtual instrument and a COB module of the sensor.

15. The system of claim 13 wherein the sensor is disposed on the patient simulator.

16. The system of claim 13 wherein the sensor is disposed on a skin overlay which is removably attached to the patient simulator.

17. An interactive education system for teaching patient care to a user, the system comprising:
a patient simulator;
a virtual instrument for use with the patient simulator in performing patient care activities; and
an interface module having:
(i) means for sensing an interaction between the virtual instrument and the simulator, and
(ii) means for providing feedback to the user regarding the interaction between the virtual instrument and the simulator.

18. The system of claim 17 further comprising a sensor disposed on the patient simulator.

19. The system of claim 18 wherein the sensor comprises:
(i) a RF ID tag; and

(ii) a coil connected to the RF ID tag for broadcasting a unique set of RF signals when interrogated by an excitation frequency.

20. A patient simulator for receiving simulated patient care activity comprising:
a maternal portion;
a fetal portion disposed in the maternal portion; and
means for automatically delivering the fetal portion from the maternal portion to simulate child birth.

21. The simulator of claim 20 wherein the means for automatically delivering the fetal portion from the maternal portion to simulate child birth include:
(i) a track disposed within the maternal portion; and
(ii) a ram attachable to the fetal portion for moving the fetal portion down the track.

22. The simulator of claim 21 wherein the ram translates the fetal portion out of the maternal portion.

23. The simulator of claim 22 wherein the ram includes a projection for producing rotational movement of the fetal portion.

24. The simulator of claim 22 wherein the ram has at least one lever for engaging a cam disposed on the track to produce rotation of the fetal portion during translation.

25. The simulator of claim 21 wherein the ram produces internal and external rotational movement of the fetal portion, relative to the maternal portion.

26. The simulator of claim 21 wherein the ram is driven by a hand crank.

27. The simulator of claim 21 wherein the ram is driven by a motor.

28. The simulator of claim 27 wherein the motor is controlled by a control box.

29. The simulator of claim 27 wherein the motor is controlled by software.

30. A child birthing device for automatically delivering a fetal manikin from a maternal manikin to simulate child birth, comprising:

a track for disposed within the maternal manikin; and

a ram attachable to the fetal manikin for moving the fetal manikin down the track.

31. The device of claim 30 wherein the ram translates the fetal manikin out of the maternal manikin.

32. The device of claim 30 wherein the ram includes a projection for producing rotational movement of the fetal manikin during translation.

33. The device of claim 30 wherein the ram produces internal and external rotational movement of the fetal portion, relative to the maternal portion.

34. The device of claim 30 wherein the ram is driven by a hand crank.

35. The device of claim 30 wherein the ram is driven by a motor.

36. The device of claim 35 wherein the motor is controlled by a control box.

37. The device of claim 35 wherein the motor is controlled by software.

38. A distensible cervix for a manikin comprising:

a ring disposed in the manikin;

a wall connected to the ring, wherein the wall is of an elastic material, and wherein the wall has a central gathering that defines a port.

39. The cervix of claim 38 wherein the gathering has an associated elastomeric element disposed interiorly to enhance the elasticity of the port.

40. The cervix of claim 38 wherein the port expands from two to ten centimeters in diameter as an associated fetal simulator is pushed through the port.

41. The cervix of claim 40 wherein the shape of the head of the fetal simulator causes expansion to correlate to fetal descent in the manikin.

42. The cervix of claim 38 further comprising reversible fastening means to hold the ring in the manikin.

43. A patient simulator for receiving simulated patient care activity comprising:
a central portion;
a peripheral portion disposed radially distant from the central portion; and
means for independently changing the color of the central portion and peripheral portion to simulate cyanosis of the simulator.

44. The simulator of claim 43 wherein the means are logically linked to ventilation of the patient simulator.

45. The simulator of claim 43 wherein the means are controlled by a user.

46. The simulator of claim 43 wherein the means for independently changing the color of the central portion and peripheral portion to simulate cyanosis of the simulator comprise:

(i) a thermochromatic dye dispersed into clear vinyl paint and applied to the central portion and the peripheral portion; and

(ii) at least one resistance heater disposed in the central portion, and at least one resistance heater disposed in the peripheral portion to provide heat energy, thereby causing the color to disappear.

47. The simulator of claim 46 wherein the at least one resistance heater disposed in the central portion and at least one resistance heater disposed in the peripheral portion have separate controls.

48. The simulator of claim 46 further comprising at least one heat sink to allow for faster return of coloration.

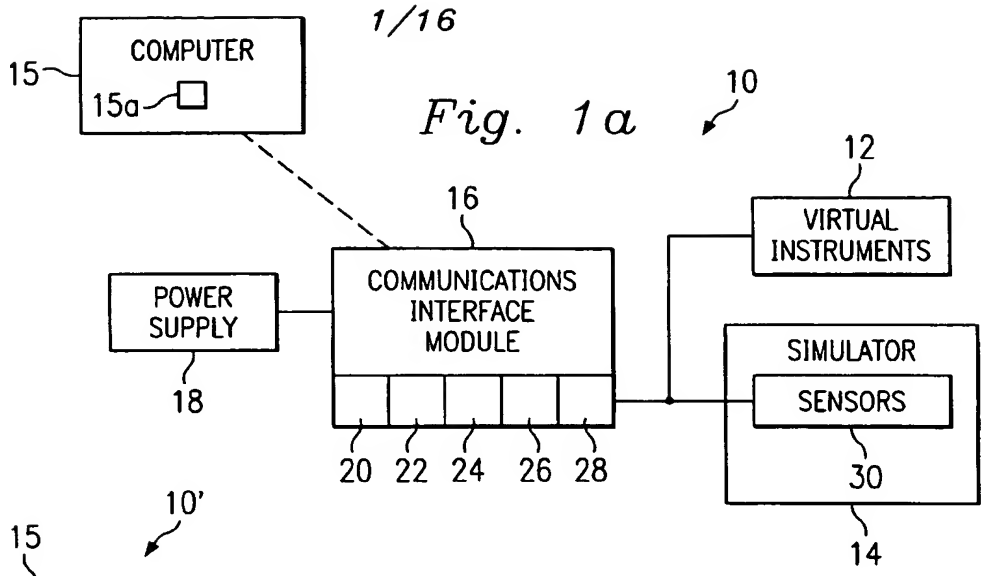


Fig. 1a

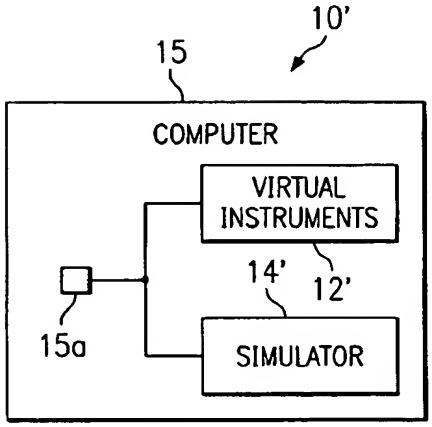


Fig. 1b

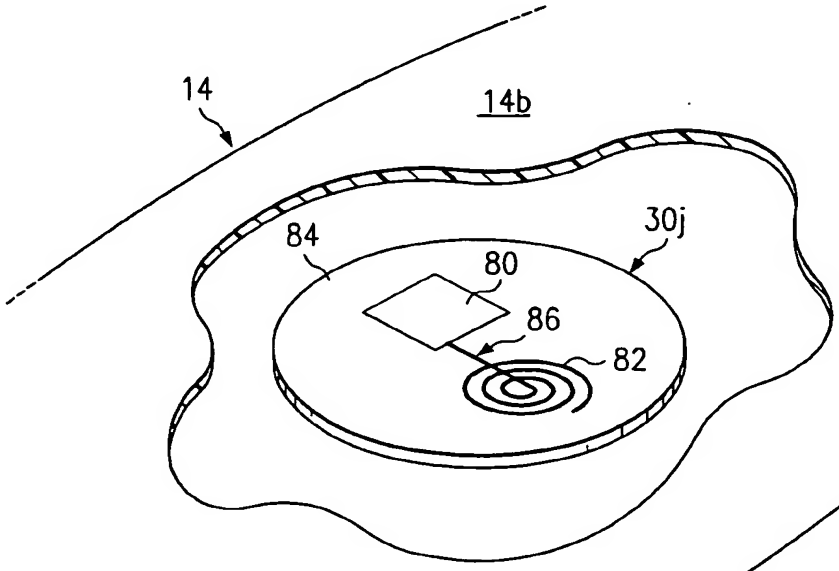


Fig. 3b

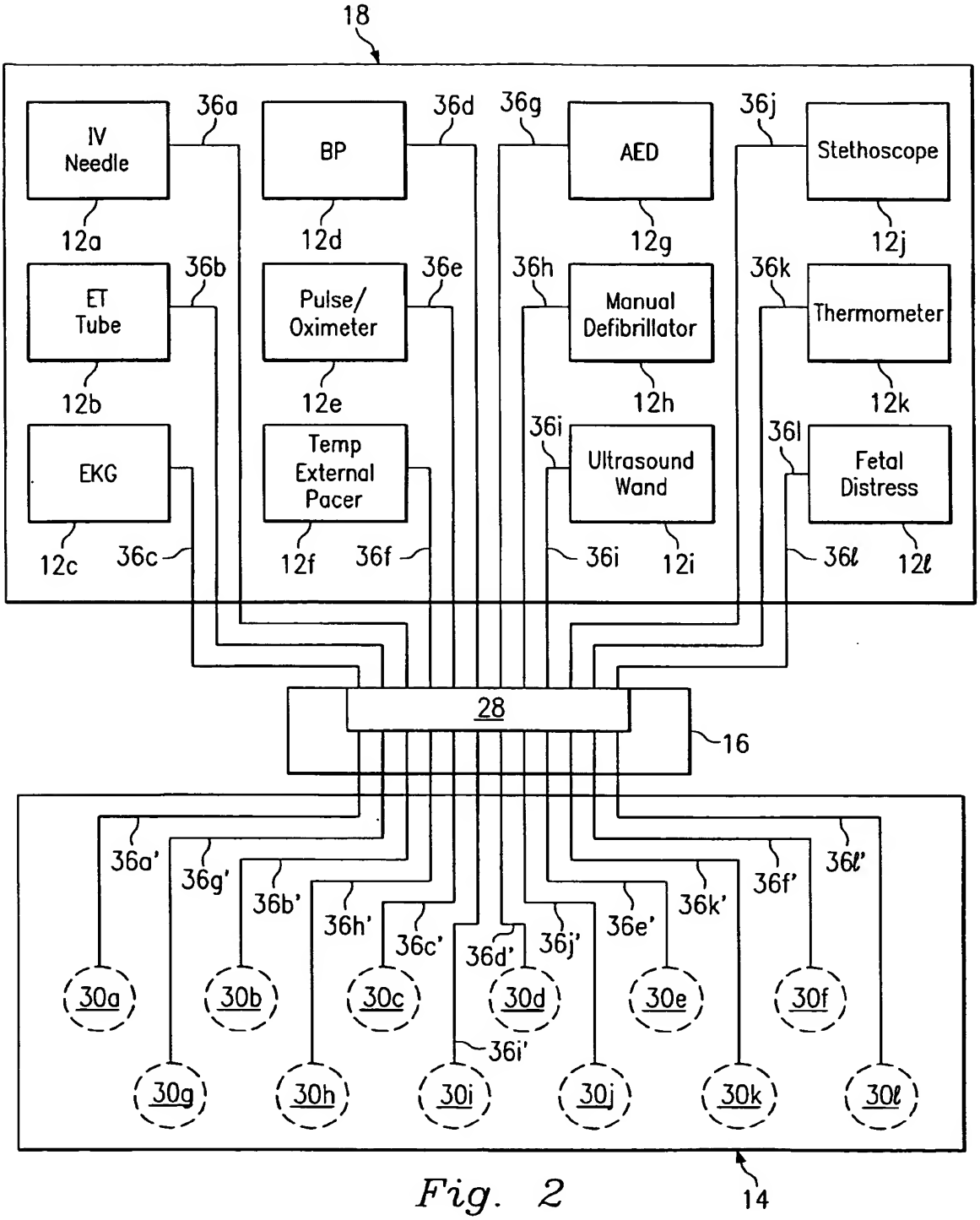

18
IV Needle
36a
BP
36d
36g
AED
36j
Stethoscope
12a
12d
12g
12j
ET Tube
36b
Pulse/ Oximeter
36e
36h
Manual Defibrillator
36k
Thermometer
12b
12e
12h
12k
EKG
Temp External Pacer
36i
Ultrasound Wand
36l
Fetal Distress
12c
36c
12f
36f
36i
12i
36l
12l
28
16
36a'
36g'
36b'
36h'
36c'
36d'
36j'
36e'
36k'
36f'
36l'
30a
30b
30c
30d
30e
30f
36i'
30g
30h
30i
30j
30k
30l
14

Fig. 2

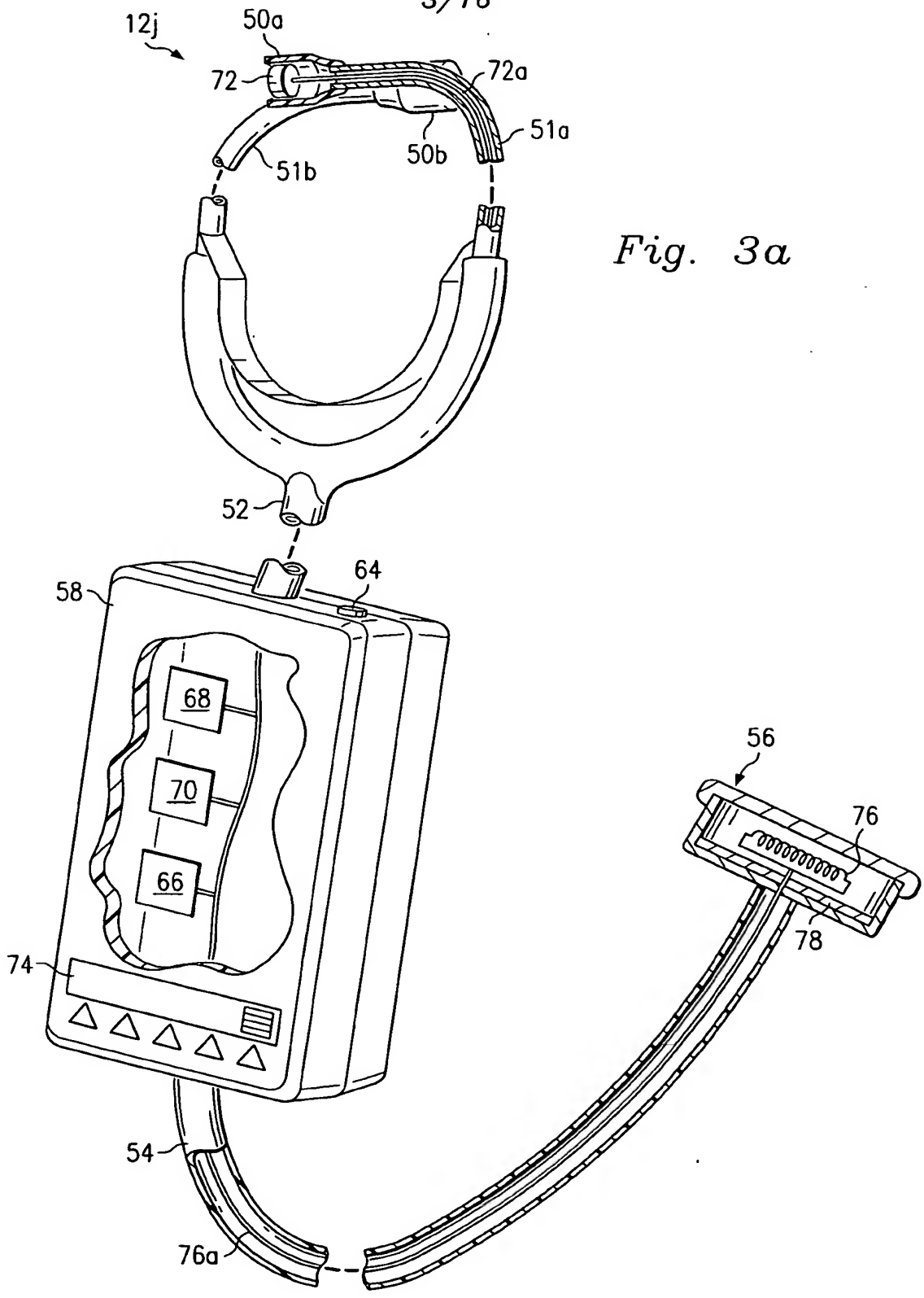


Fig. 3a

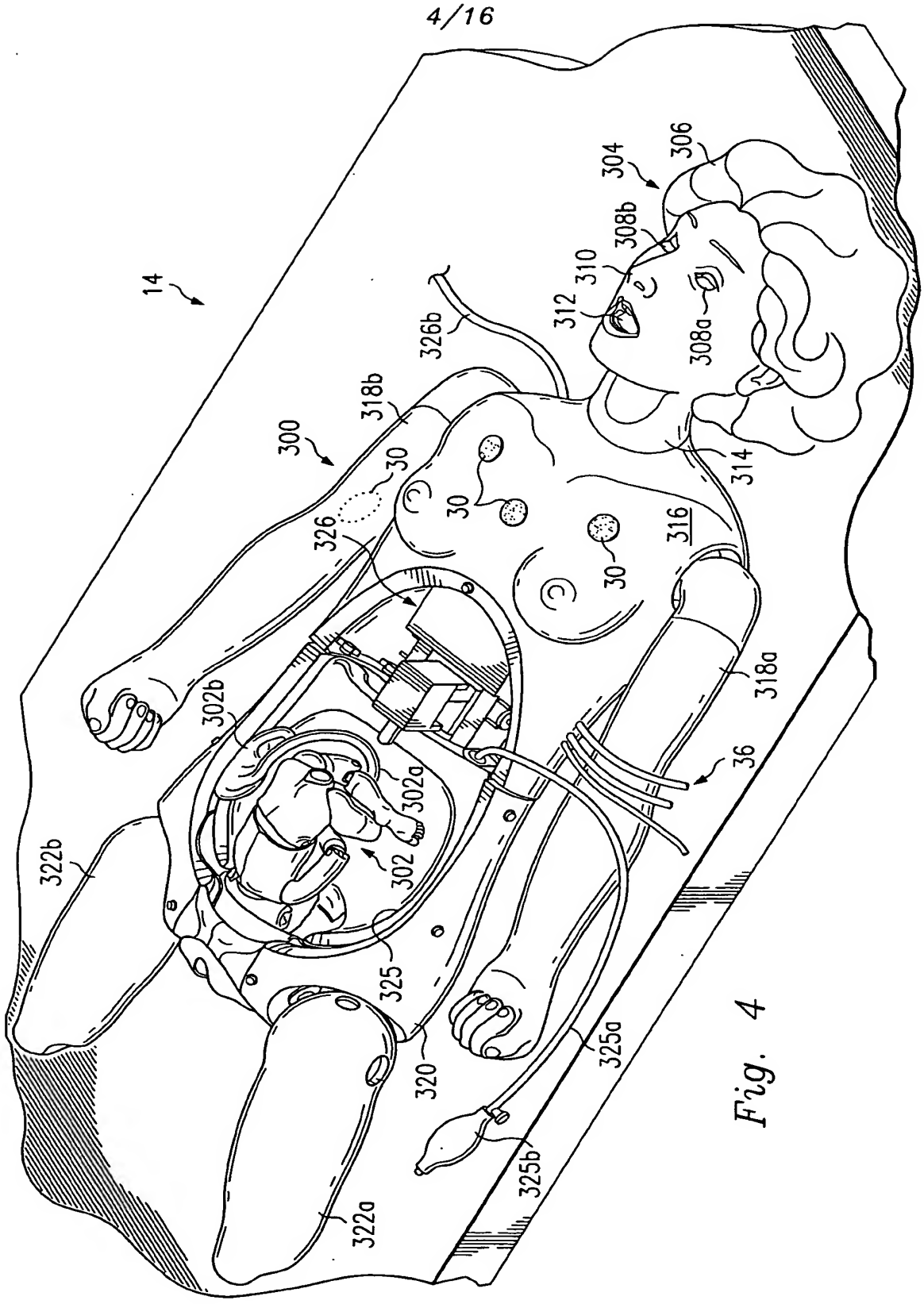

14
300
302
302a
302b
304
306
308a
308b
310
312
314
316
318a
318b
320
322a
322b
325
325a
325b
326
326b
30
36

Fig. 4

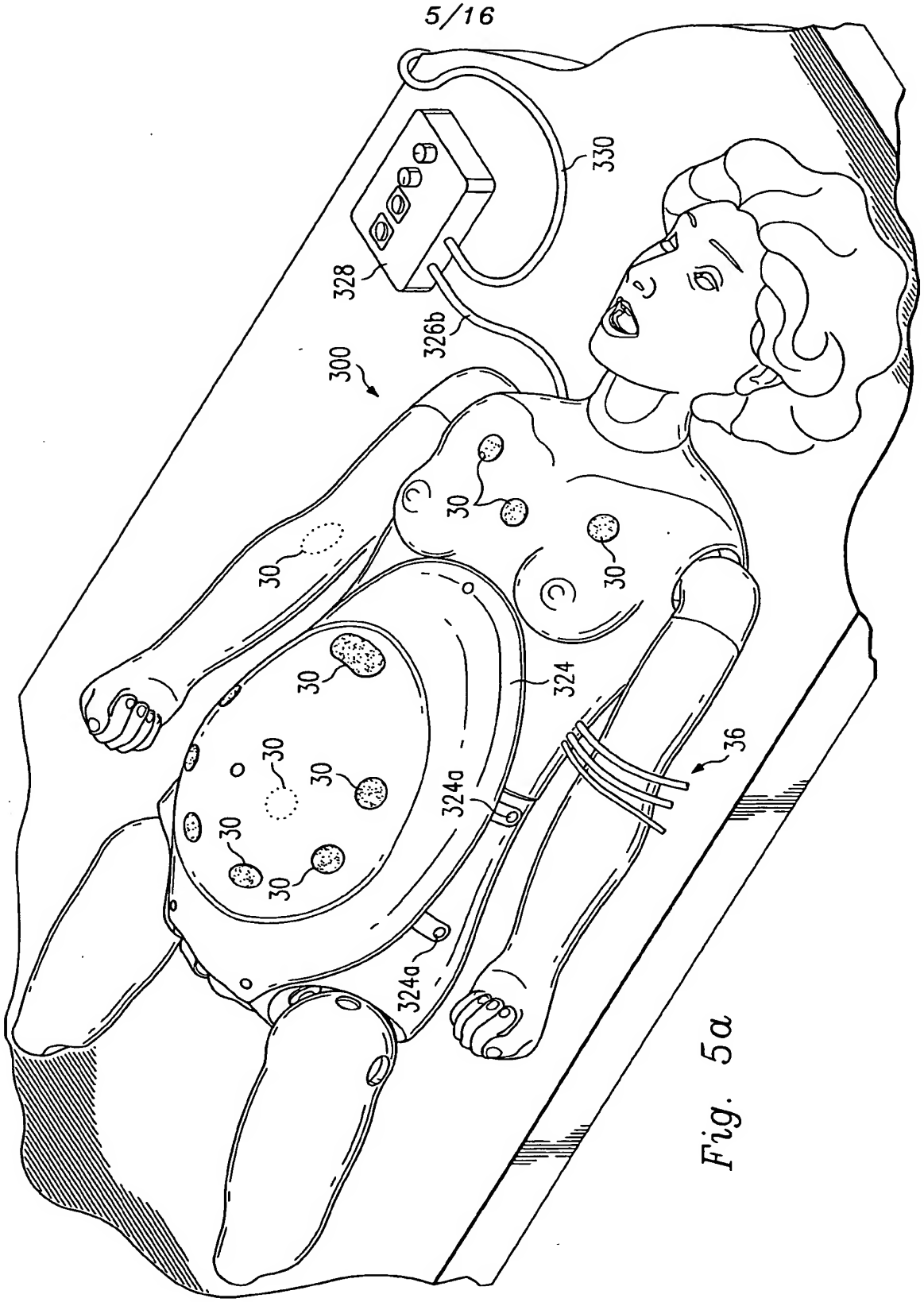


Fig. 5a

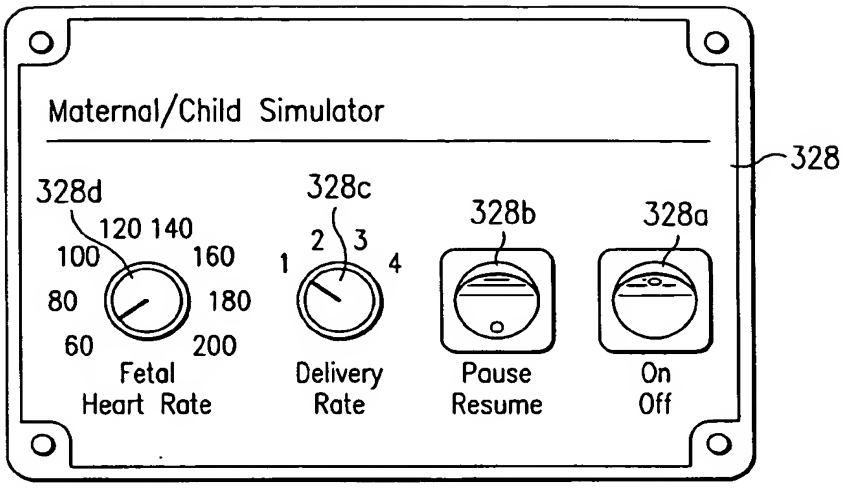

Maternal/Child Simulator
328
328d
120 140
100
160
80
180
60
200
Fetal
Heart Rate
328c
2
3
1
4
Delivery
Rate
328b
Pause
Resume
328a
On
Off

Fig. 5b

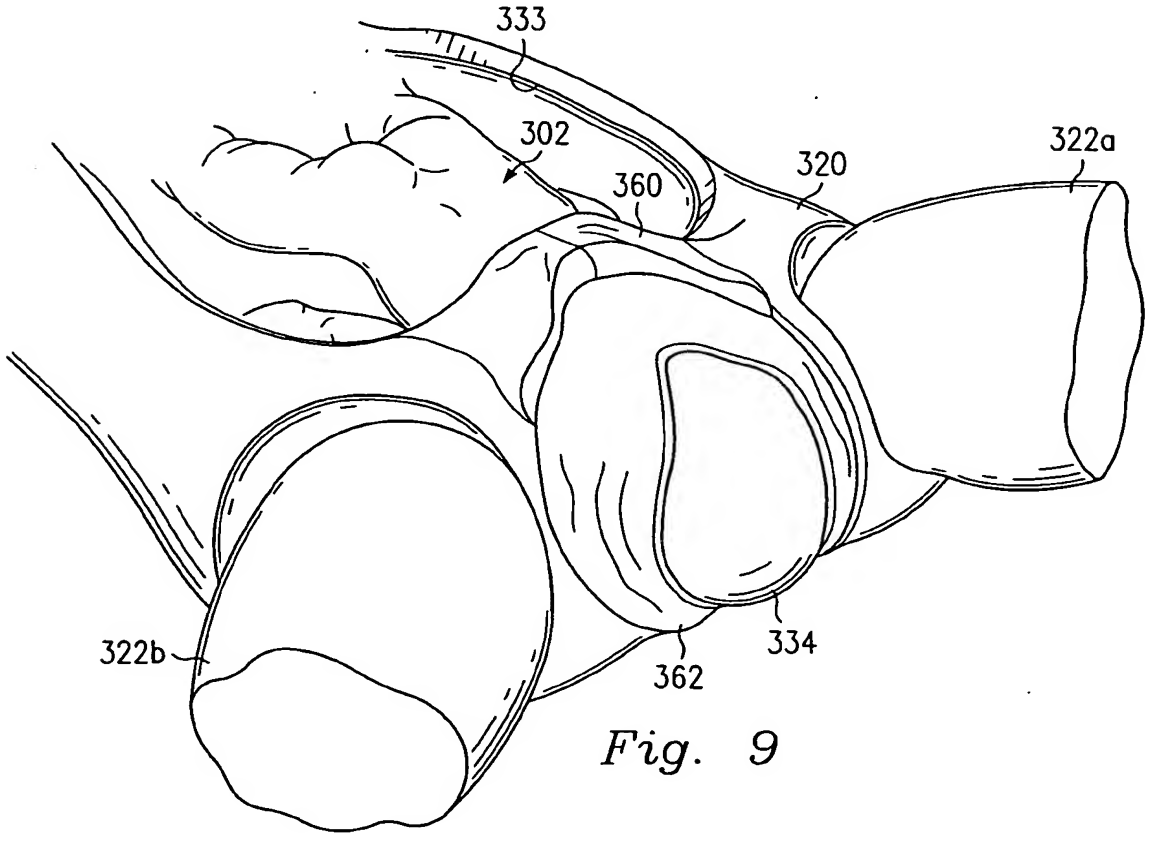

333
302
360
320
322a
322b
362
334

Fig. 9

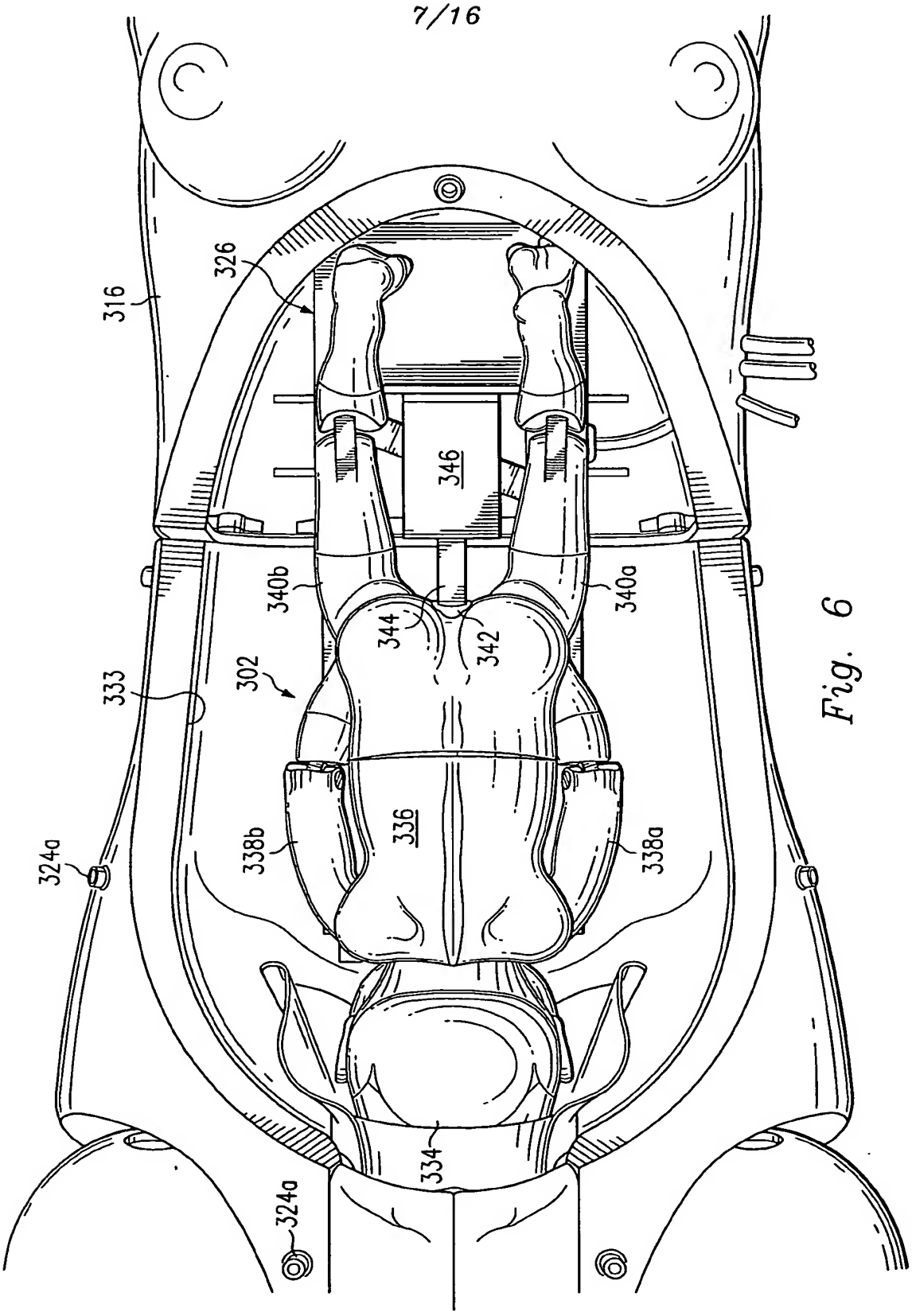

316
326
346
340b
340a
344
342
302
333
336
338b
338a
324a
334
324a

Fig. 6

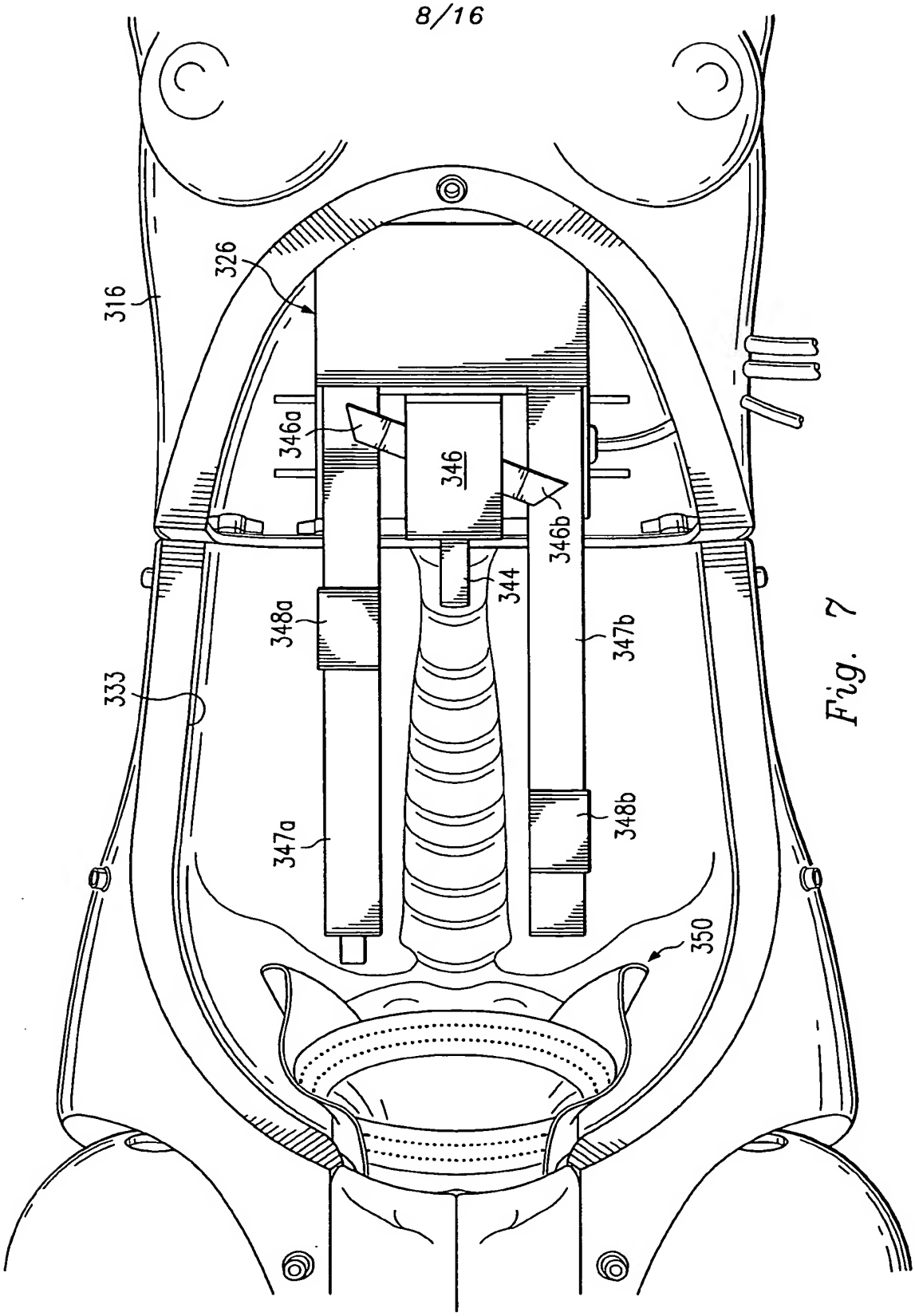


Fig. 7

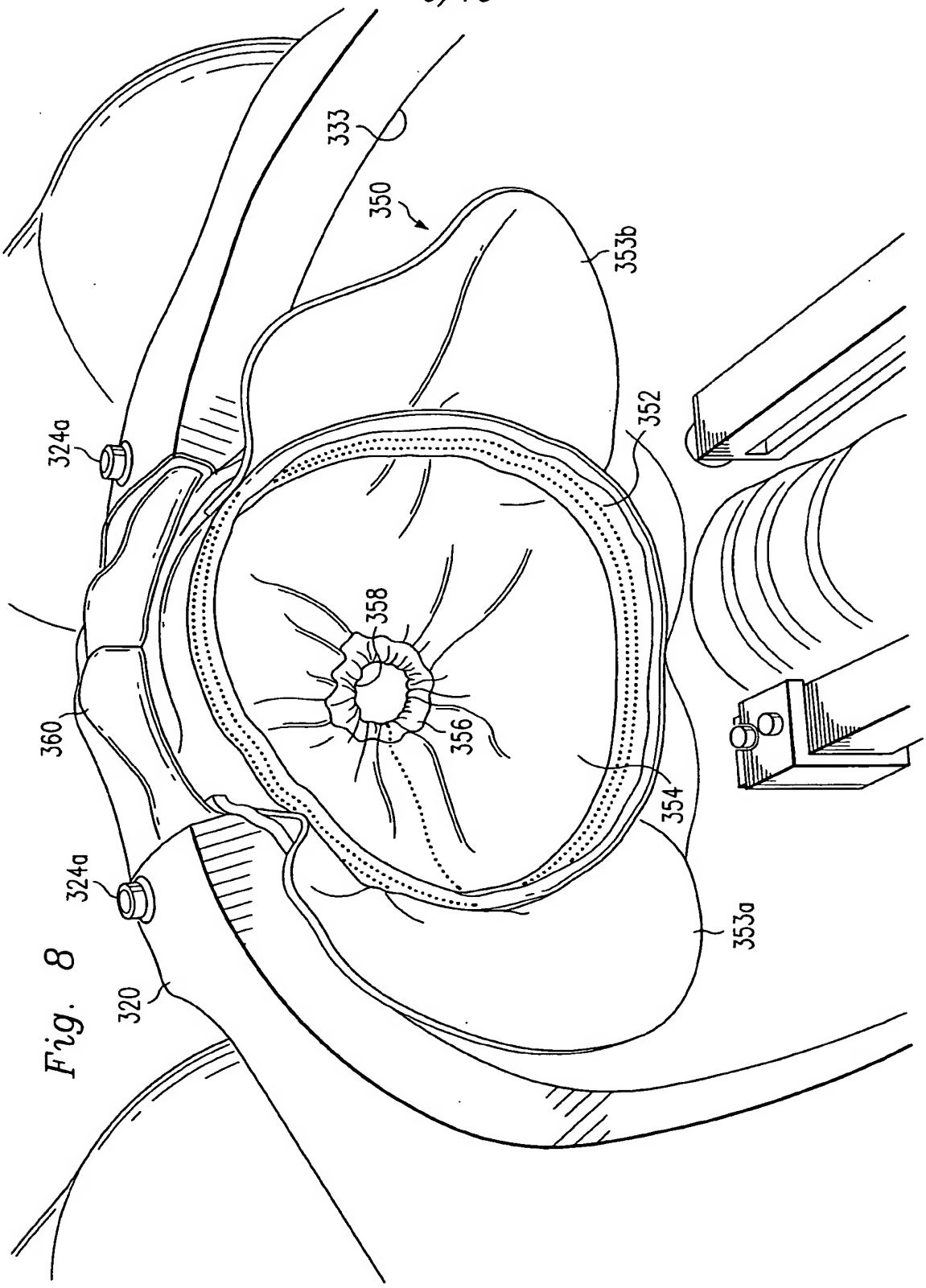


Fig. 8

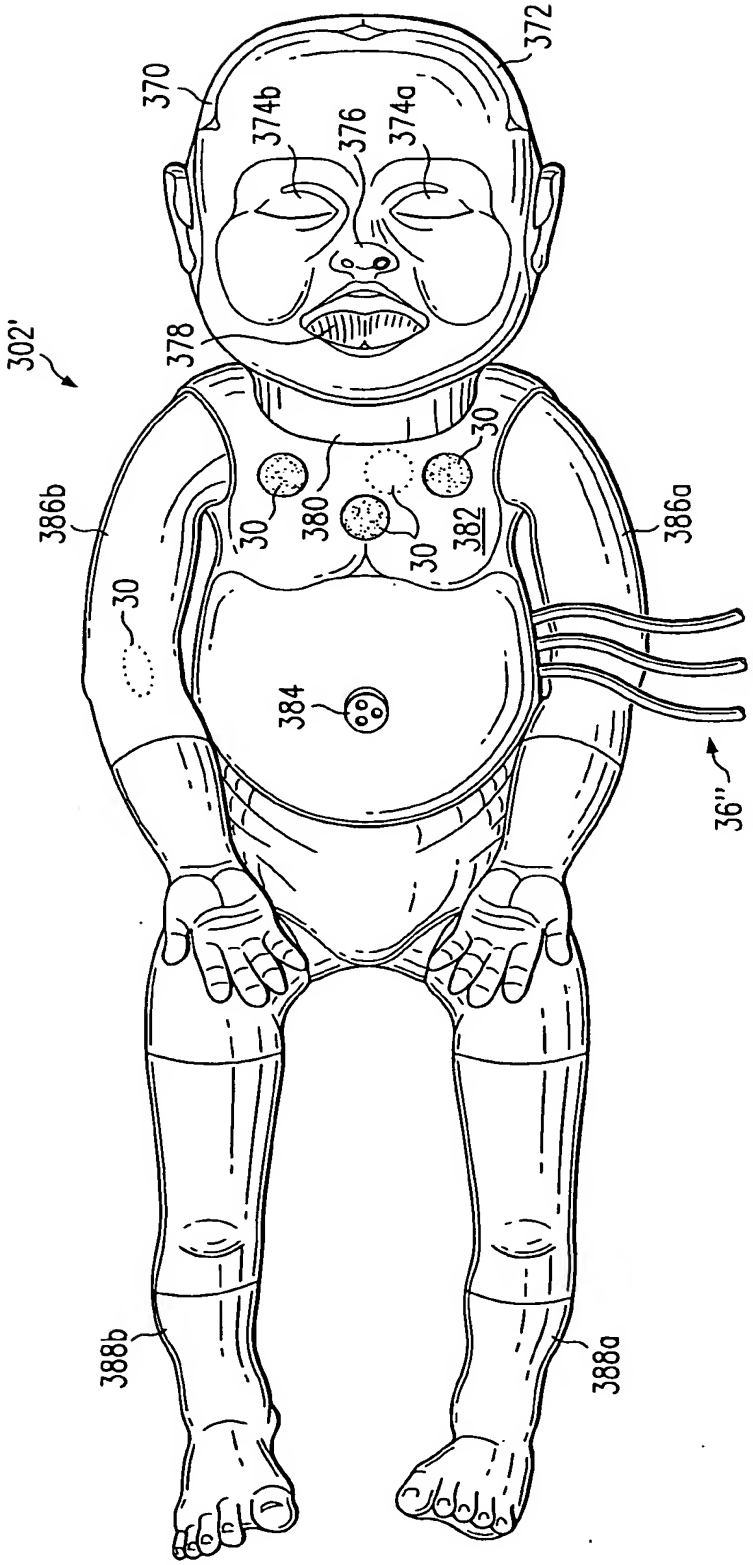

372
370
374b
376
374a
302'
378
30
386b
30
380
382
386a
30
30
384
36''
388b
388a

Fig. 10

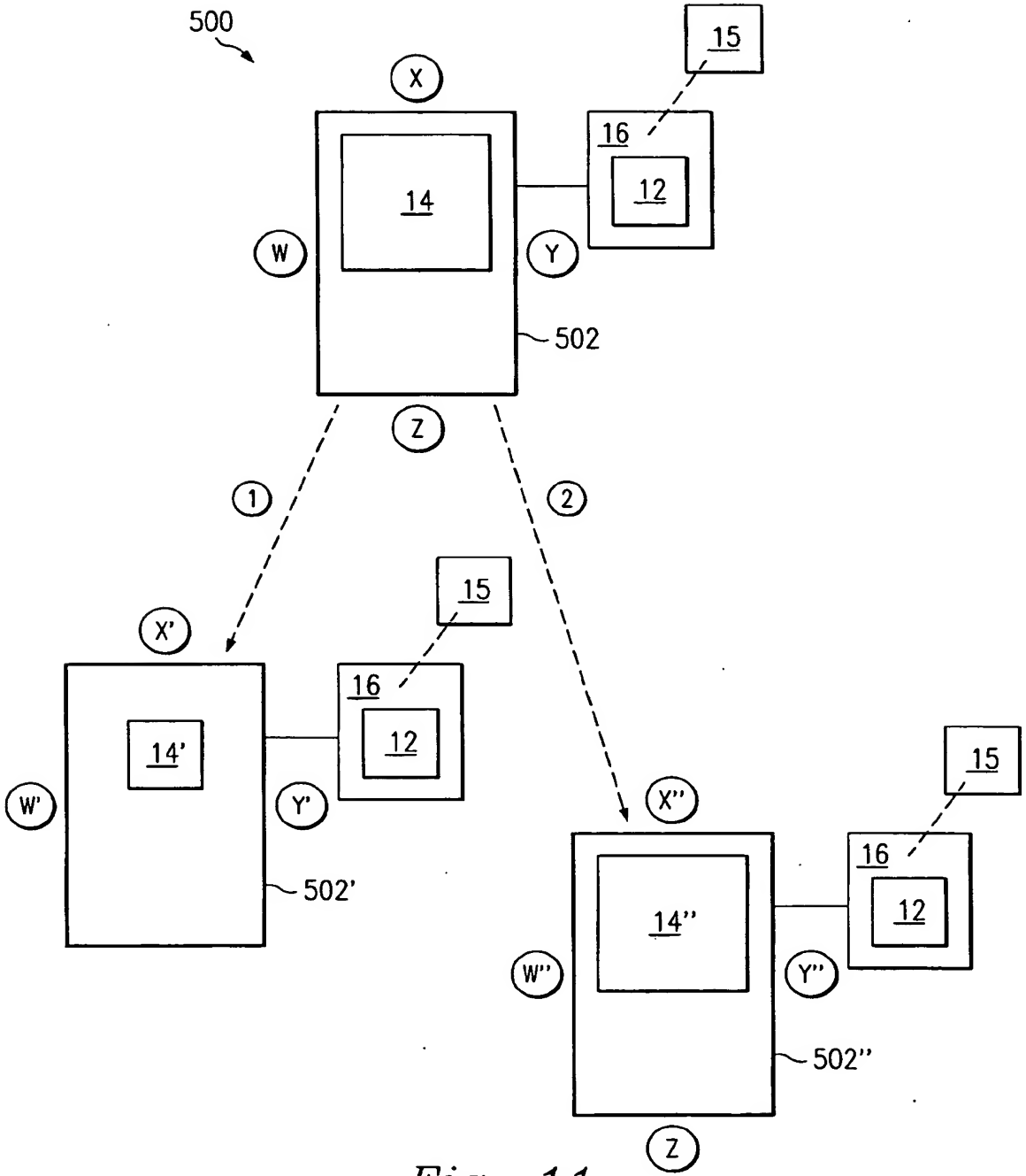


Fig. 11

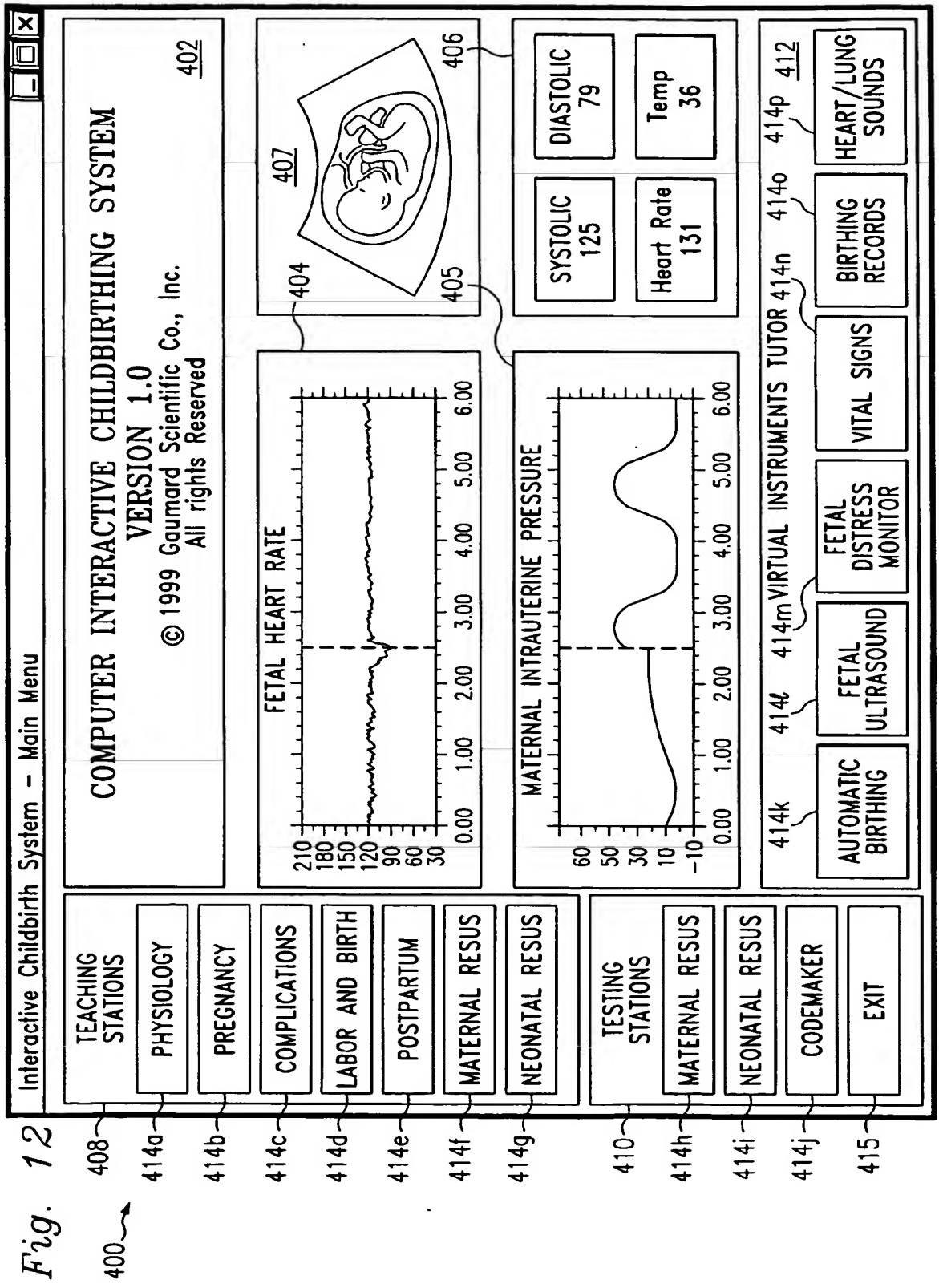

Interactive Childbirth System - Main Menu
COMPUTER INTERACTIVE CHILDBIRTHING SYSTEM
VERSION 1.0
© 1999 Gaumard Scientific Co., Inc.
All rights Reserved
402
FETAL HEART RATE
MATERNAL INTRAUTERINE PRESSURE
404
405
406
407
SYSTOLIC 125
DIASTOLIC 79
Heart Rate 131
Temp 36
TEACHING STATIONS
PHYSIOLOGY
PREGNANCY
COMPLICATIONS
LABOR AND BIRTH
POSTPARTUM
MATERNAL RESUS
NEONATAL RESUS
TESTING STATIONS
MATERNAL RESUS
NEONATAL RESUS
CODEMAKER
EXIT
AUTOMATIC BIRTHING
FETAL ULTRASOUND
FETAL DISTRESS MONITOR
VITAL SIGNS
VIRTUAL INSTRUMENTS TUTOR
BIRTHING RECORDS
HEART/LUNG SOUNDS
412
408
400
410
414a
414b
414c
414d
414e
414f
414g
414h
414i
414j
414k
414l
414m
414n
414o
414p
415

Fig. 12

Fig. 13

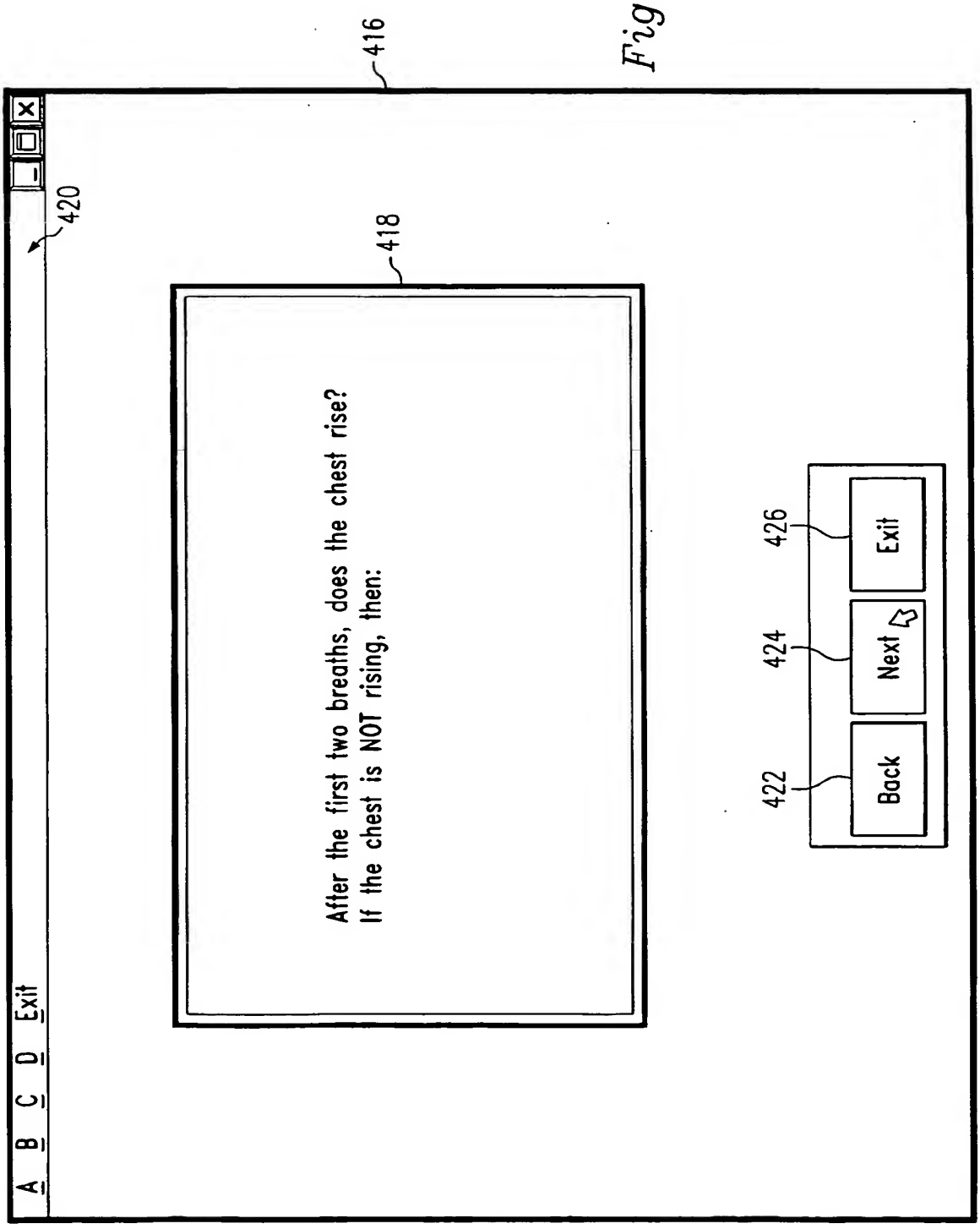
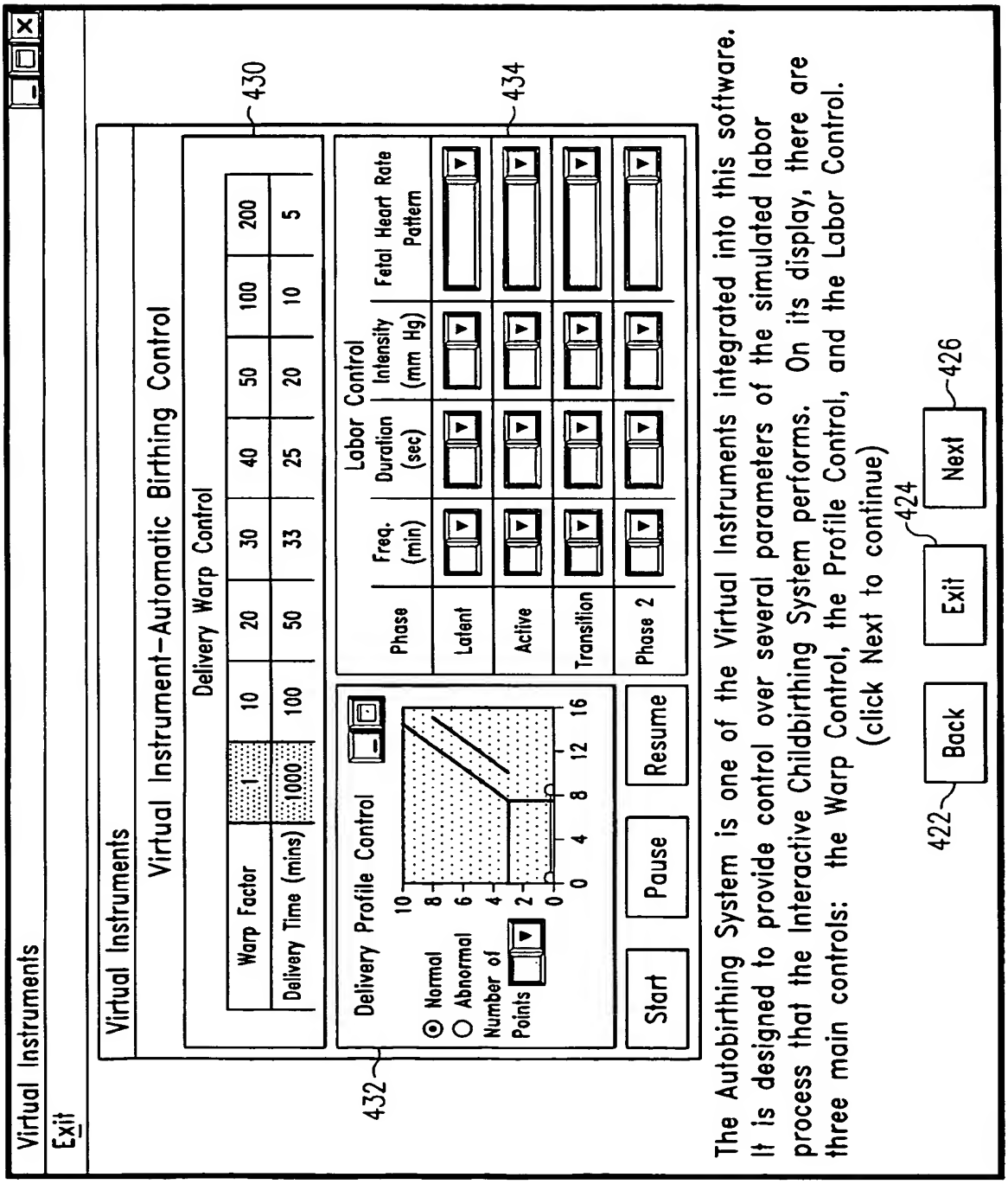

416
420
418
A B C D Exit
After the first two breaths, does the chest rise?
If the chest is NOT rising, then:
426
Exit
424
Next
422
Back

Fig. 14


Virtual Instruments
Exit
Virtual Instruments
Virtual Instrument–Automatic Birthing Control
Delivery Warp Control
430
Warp Factor
Delivery Time (mins)
1
1000
10
100
20
50
30
33
40
25
50
20
100
10
200
5
Labor Control
434
Phase
Freq. (min)
Duration (sec)
Intensity (mm Hg)
Fetal Heart Rate Pattern
Latent
Active
Transition
Phase 2
Delivery Profile Control
432
Normal
Abnormal
Number of Points
Start
Pause
Resume
The Autobirthing System is one of the Virtual Instruments integrated into this software. It is designed to provide control over several parameters of the simulated labor process that the Interactive Childbirthing System performs. On its display, there are three main controls: the Warp Control, the Profile Control, and the Labor Control.
(click Next to continue)
422
Back
424
Exit
Next
426

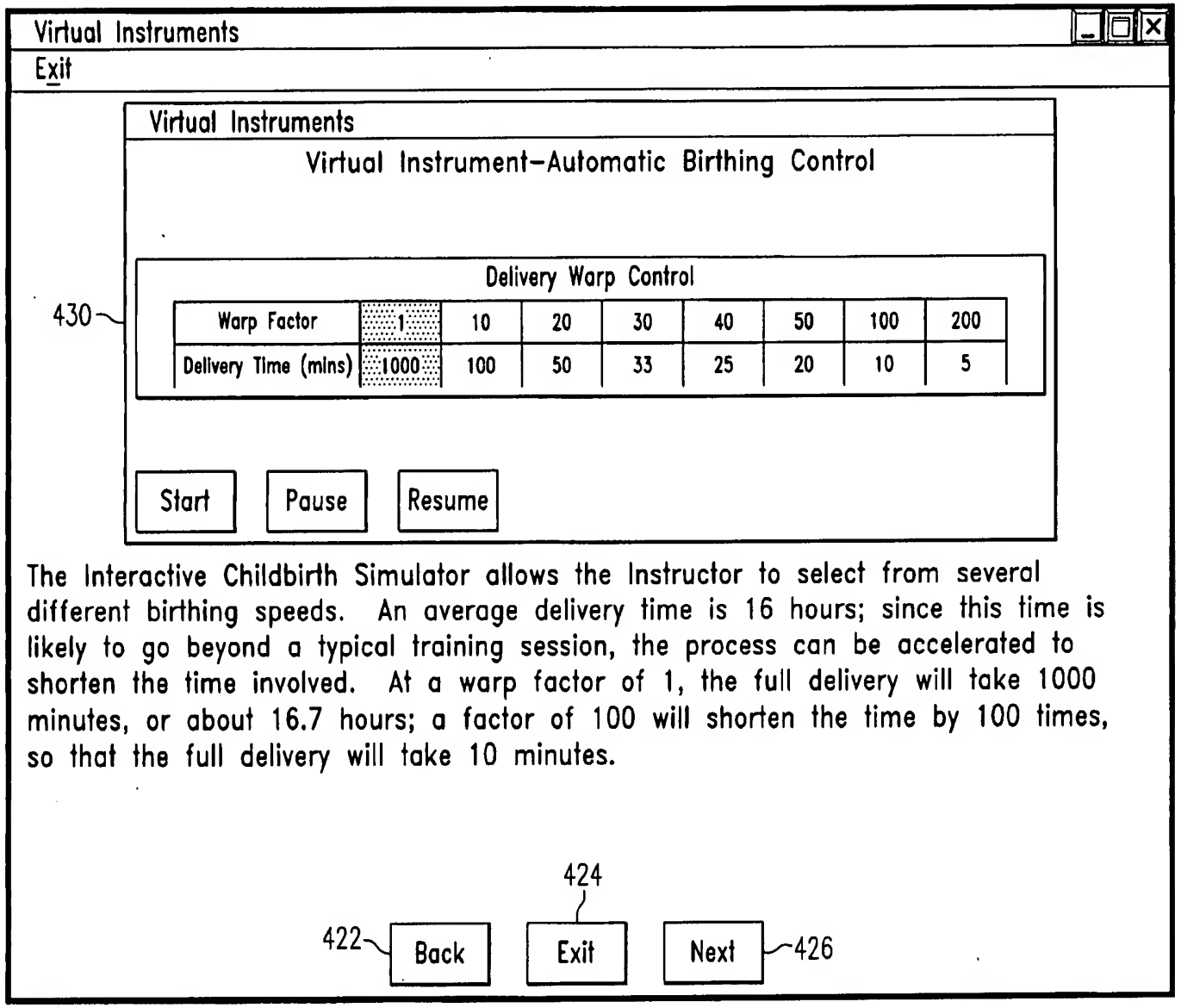
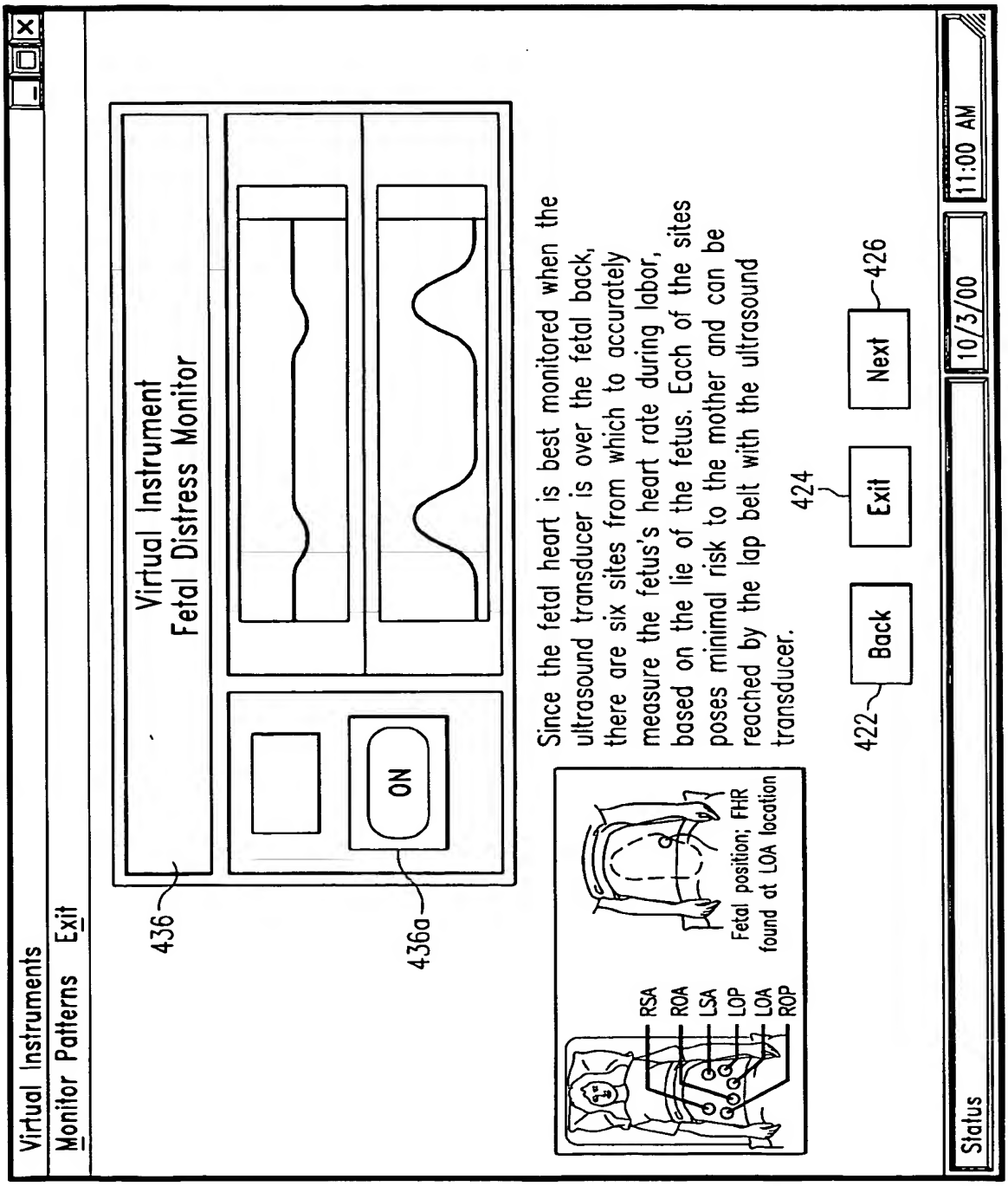

Virtual Instruments
Exit
Virtual Instruments
Virtual Instrument–Automatic Birthing Control
Delivery Warp Control
430
Warp Factor 1 10 20 30 40 50 100 200
Delivery Time (mins) 1000 100 50 33 25 20 10 5
Start
Pause
Resume
The Interactive Childbirth Simulator allows the Instructor to select from several different birthing speeds. An average delivery time is 16 hours; since this time is likely to go beyond a typical training session, the process can be accelerated to shorten the time involved. At a warp factor of 1, the full delivery will take 1000 minutes, or about 16.7 hours; a factor of 100 will shorten the time by 100 times, so that the full delivery will take 10 minutes.
424
422
Back
Exit
Next
426

Fig. 15

Fig. 16


Virtual Instruments
Monitor Patterns Exit
Virtual Instrument
Fetal Distress Monitor
436
ON
436a
RSA
ROA
LSA
LOP
LOA
ROP
Fetal position; FHR found at LOA location
Since the fetal heart is best monitored when the ultrasound transducer is over the fetal back, there are six sites from which to accurately measure the fetus's heart rate during labor, based on the lie of the fetus. Each of the sites poses minimal risk to the mother and can be reached by the lap belt with the ultrasound transducer.
424
422
Back
Exit
Next
426
Status
10/3/00
11:00 AM

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/42512

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :G09B 23/28
US CL :434/262, 265, 266, 267, 268, 272, 273
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 434/262, 265, 266, 267, 268, 269, 270, 272, 273, 275

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST
search terms: simulator, childbirth

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,822,486 A (KNAPP ET AL) 09 JULY 1974, See Whole Document.	20, 38-42
X	US 5,509,810 A (SCHERTZ ET AL) 23 APRIL 1996, See Whole Document.	1-15, 17-19
X, &	US 5,853,292 A (EGGERT ET AL) 29 DECEMBER 1998, See Whole Document.	1-5, 7-13, 15, 17, 18
X, P, &	US 6,193,519 B1 (EGGERT) 27 FEBRUARY 2001, See Whole Document.	1-5, 7-13, 15, 17, 18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 26 NOVEMBER 2001	Date of mailing of the international search report 22 JAN 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JOHN ROVNAK Telephone No. (703) 308-5[illegible]

Sheila Venkey
Paralegal Specialist
Technology Center 3700

Form PCT/ISA/210 (second sheet) (July 1998)*